Micsig®

Micsig Tablet Oscilloscope

Smart Series



USER MANUAL

Shenzhen Micsig Technology Co., Ltd.

Version Info

Version	Date	Remarks
V1.0	2022.04	

Preface

Dear customers,

Congratulations! Thank you for buying Micsig instrument. Please read this manual carefully before use and particularly pay attention to the “Safety Precautions”.

If you have read this manual, please keep it properly for future reference.

The information contained herein are furnished in an “as-is” state, and may be subject to change in future versions without notice.

The standard applicable for this product: GB/T15289-2013.

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Chapter 1. Safety Precautions

1.1 Safety Precautions

The following safety precautions must be understood to avoid personal injury and prevent damage to this product or any products connected to it. To avoid possible safety hazards, it is essential to follow these precautions while using this product.

- **Only professionally trained personnel can operate the maintenance procedure.**
- **Avoid fire and personal injury.**
- **Use proper power cord.** Use only the power cord specified for this product and certified for the country/region of use.
- **Connect and disconnect probes properly.** Connect the instrument probe correctly, and its ground terminal is ground phase. Do not connect or disconnect probes or test leads while they are connected to a voltage source.

Disconnect the probe input and the probe reference lead from the circuit under test before disconnecting the probe from the measurement product.

- **Ground the product. To avoid electric shock, the instrument grounding conductor must be connected to earth ground**.
- **Observe all terminal ratings**. To avoid fire or shock hazard, observe all rating and markings on the product. Consult the product manual for further information of ratings before making connections to the product.
- **User correct probes**. To avoid excessive electric shock, use only correct rated probes for any measurement.
- **Disconnect AC power**. The adapter can be disconnected from AC power and the user must be able to access the adapter at any time.
- **Do not operate without covers**. Do not operate the product with covers or panels removed.
- **Do not operate with suspected failures**. If you suspect that there is damage to this product, have it inspected by service personnel designated by Micsig.

- **Use adapter correctly.** Supply power or charge the equipment by power adapter designated by Micsig, and charge the battery according to the recommended charging cycle.
- **Avoid exposed circuitry.** Do not touch exposed connections and components when power is present.
- **Provide proper ventilation.**
- **Do not operate in wet/damp conditions.**
- **Do not operate in a flammable and explosive atmosphere.**
- **Keep product surfaces clean and dry.**
- **The disturbance test of all models complies with Class A standards, based on EN61326:1997+A1+A2+A3, but do not meet Class B standards.**

Measurement Category

The Smart series oscilloscope is intended to be used for measurements in Measurement Category I.

Measurement Category Definition

Measurement category I is for measurements performed on circuits not directly connected to the MAINS. Examples are measurements on circuits not derived from MAINS, and specially protected (internal) MAINS derived circuits. In the latter case, transient stresses are variable; for that reason, the user must understand the transient withstand capability of the equipment.

Warning

IEC Measurement Category. Under IEC Category I mounting conditions, the input terminal can be connected to the circuit terminal with a maximum line voltage of 300Vrms. To avoid the risk of electric shock, the input terminal should not be connected to the circuit with a line voltage greater than 300Vrms. Instantaneous overvoltage is present in circuits that are isolated from the mains supply. The Smart series digital oscilloscope is designed to safely withstand sporadic transient overvoltage up to 1000Vpk. Do not use this equipment for any measurements in circuits where the instantaneous overvoltage exceeds this value.

1.2 Safety Terms and Symbols

Terms in the manual

These terms may appear in this manual:

⚠**Warning.** *Warning statements indicate conditions or practices that could result in injury or loss of life.*

⚠**Caution.** *Caution statements indicate conditions or practices that could result in damage to this product or other property.*

Terms on the product

These terms may appear on the product:

Danger indicates an injury hazard immediately accessible as you read the marking.

Warning indicates an injury hazard not immediately accessible as you read the marking.

Caution indicates a hazard to this product or other properties.

Symbols on the product

The following symbols may appear on the product:



Hazardous Voltage



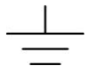
Caution Refer to Manual



Protective Ground Terminal



Chassis Ground



Measurement Ground Terminal

Please read the following safety precautions to avoid personal injury and prevent damage to this product or any products connected to it. To avoid possible hazards, this product can only be used within the specified scope.

⚠**Warning**

If the instrument input port is connected to a circuit with the peak voltage higher than 42V or the power exceeding 4800VA, to avoid electric shock or fire:

- *User only insulated voltage probes supplied with the instrument, or the equivalent product indicated in the schedule.*
- *Before use, inspect voltage probes, test leads, and accessories for mechanical damage and replace when damaged.*
- *Remove voltage probes and accessories not in use.*
- *Plug the battery charger into the AC outlet before connecting it to the instrument.*

Chapter 2. Quick Start Guide of Oscilloscope

This chapter contains checks and operations of the oscilloscope. You are recommended to read them carefully to understand appearance, power on/off, settings and related calibration requirements of the Smart series oscilloscope.

- Inspect package contents
- Use bracket
- Side panel & rear panel
- Front panel
- Power on/off the oscilloscope
- Understand the oscilloscope display interface
- Introduction to basic operations of oscilloscope
- Mouse operation
- Connect probe to the oscilloscope
- Use automatic
- Use factory settings
- Use auto-calibration
- Passive probe compensation
- Modify the language

2.1 Inspect Package Contents

When you open package after receipt, please check the instrument according to the following steps.

1) Inspect if there is any damage caused by transportation

If the package or foam is found to be severely damaged, please retain it until the instrument and accessories pass the electrical and mechanical properties test.

2) Inspect the accessories

A detailed description is given in "Annex B" of this manual. You can refer it to check if the accessories are complete. If the accessories are missing or damaged, please contact Micsig's agent or local office.

3) Inspect the instrument

If any damage to oscilloscope is found by the appearance inspection or it fails to pass the performance test, please contact Micsig's agent or local office. If the instrument is damaged due to transportation, please retain the package and contact the transportation company or Micsig's agent, and Micsig will make arrangement.

2.2 Use the Bracket

Put the front panel of the oscilloscope flatly on the table. Use your two index fingers to hold the underside of the bracket and open the bracket by slightly upwards force, as shown in Figure 2-1.



Figure 2-1 Open Bracket

2.3 Side Panel



Figure 2-2 Side Panel

There are various interfaces on the side of the oscilloscope, from left to right: Power-on button, Grounding, Probe compensation signal output, USB Host, HDMI, USB Device, Power-off lock, and Power port.

2.4 Rear Panel



Figure 2-3 Rear Panel

a) Ch1 – Ch4 are signal measurement channels

b) Aux out is an auxiliary channel, which is mainly used to measure the waveform refresh rate of the oscilloscope and cascade the current oscilloscope signal to other oscilloscopes.

2.5 Top Panel



Figure 2-4 Top Panel of Tablet Oscilloscope

On top of the oscilloscope is the Micsig UPI universal probe interface, which is designed to power active probes and automatically communicate scale factors on the scope display.

2.6 Front Panel



Figure 2-5 Front Panel of Tablet Oscilloscope

2.7 Power on/off the Oscilloscope

Power on/off the oscilloscope

First time start

- Connect power adapter to the oscilloscope, and the oscilloscope should not be pressed on the adapter cable.
- Press the power button to start the instrument.

Power on

- Press the power button to start the instrument while ensuring it is connected to a power supply.

Power off

- Press the power button , go to power-off interface, and click to turn off the instrument.
- Long press the power button for forced power-off of the instrument.

Power-off lock

- Turn the power-off lock switch to OFF, the oscilloscope cannot be turned on.

⚠ **Caution**: Forced power-off may result in loss of unsaved data, please use with caution.

2.8 Understand the Oscilloscope Display Interface

This section provides a brief introduction and description of the Smart Series oscilloscope user's interface. After reading this section, you can be familiar with the oscilloscope display interface content within the shortest possible time. The specific settings and adjustments will be detailed in subsequent chapters and sections. The following items may appear on the screen at a given time but not all items are visible. The oscilloscope interface is shown in Figure 2-6.

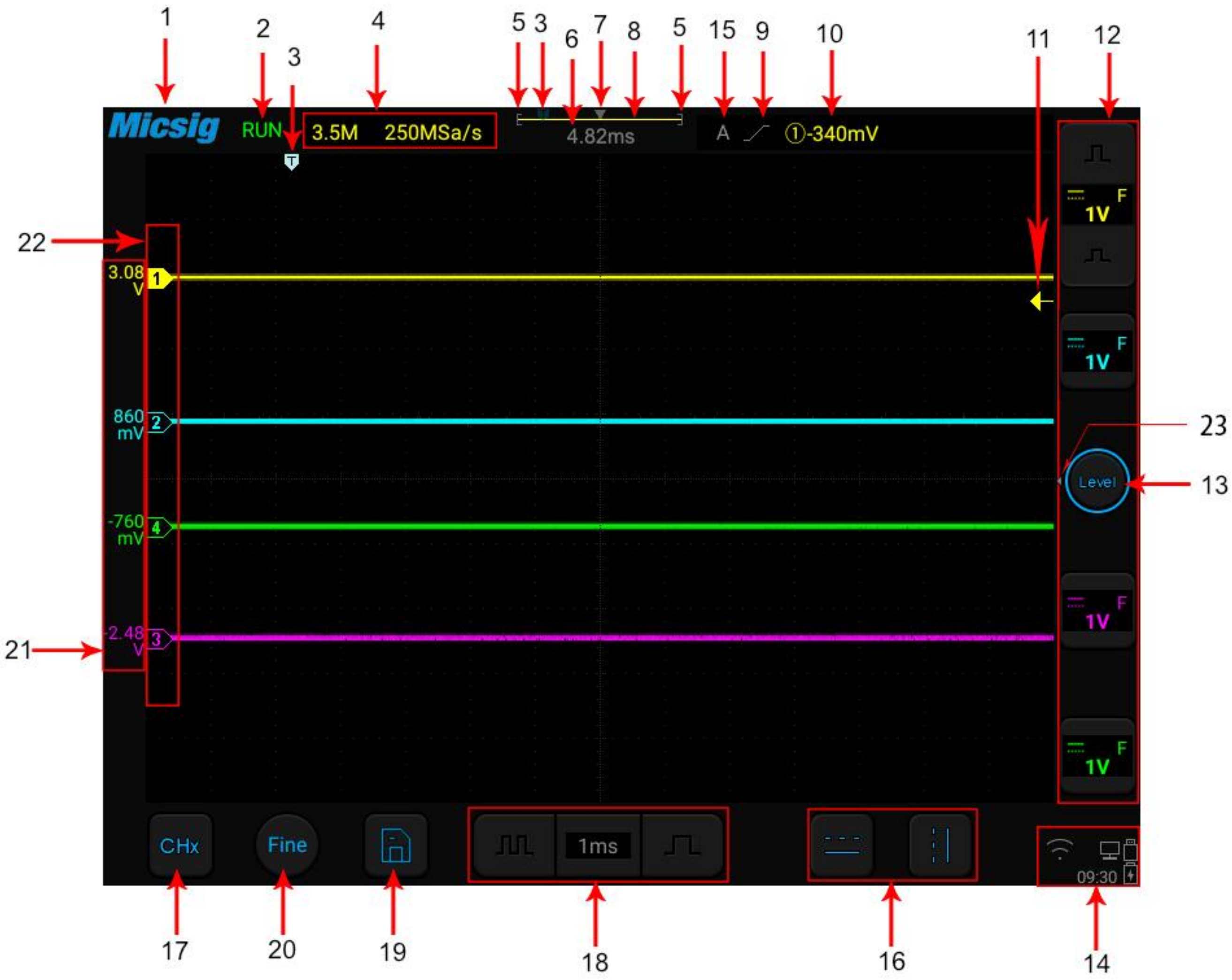
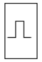
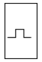


Figure 2-6 Oscilloscope Interface Display

No.	Description
1	Micsig logo
2	Oscilloscope status, including RUN, STOP, WAIT, Auto
3	Trigger point
4	Sampling rate, memory depth
5	The area in “[]” indicates the position of waveform displayed on the screen throughout the memory depth
6	Delay time, the time at which the center line of the waveform display area is relative to the trigger point
7	Center line of waveform display area
8	Memory depth indicatrix
9	Current trigger type indication
10	Current trigger source, trigger level

No.	Description
11	Trigger level indicator
12	CH1、CH2、CH3、CH4 channel icons and vertical sensitivity icon. Tap the channel icons to open channels; Click  or  to adjust the vertical sensitivity of channels; Open the channel menu by swipe left from the desired channel and swipe right to close; Display the vertical sensitivity of channels; Display couple method.
13	Trigger level adjustment, press on the button to modify the trigger level through upward and downward movements.
14	Display areas of USB-PC connection, USB connection, battery level, time etc.
15	Trigger Mode: A(auto), N(Normal).
16	Horizontal and vertical cursors open and close.
17	Current channel selection. Click to pop up the current channel switching menu to switch the current channel.

No.	Description
18	Horizontal time base control icon. Tap the left/right time base buttons to adjust the horizontal time base of the waveform. Tap the time base to open the time base table. Tap to select the desired time base.
19	Quick save. Tap to quickly save the waveform as a reference waveform.
20	Fine adjustment button. Tap the button to finely adjust the last operation, including waveform position, trigger level position, trigger point and cursor position.
21	The vertical position value of the channel indicator.
22	Channel indicator can indicate the zero-level position of the open channel.
23	Trigger quick start menu indicator: swipe left to open trigger quick start menu

Table 2-1 Description of Oscilloscope Display Interface

2.9 Introduction Basic Operations of Touch Screen

The Smart Series oscilloscope operates mainly by tap, swipe, single-finger drag.

Tap

Tap button on the touch screen to activate the corresponding menu and function. Tap any blank space on the screen to exit the menu.

Swipe

Single-finger swipe: to open/close menus, including main menu, shortcut menu button and other channel menu operations. For example, the main menu is opened as shown in Figure 2-7. The closing method is the opposite of the opening method.



Figure 2-7 Slide out of Main Menu

Tap the options in the main menu to enter the corresponding submenu.

↕ Single-finger drag

For coarse adjustments of vertical position, trigger point, trigger level, cursor, etc. of the waveform. Refer to “4.1 Horizontal Move Waveform” and “5.3 Adjust Vertical Position” for details.

2.10 Mouse Operation

Connect the mouse to the “USB Host” interface, then operate the oscilloscope with the mouse. The left button, right button and scroll wheel of the mouse have the same functions as the finger touch function. Figure 2-8 is a schematic diagram of the mouse single click to select “Run/Stop” function under the “Menu” option in the “Short-cut Menus”.



Figure 2-8 Mouse Cursor

2.11 Connect Probe to the Oscilloscope

1) Connect the probe to the oscilloscope channel BNC connector.

2) Connect the retractable tip on the probe to the circuit point or measured equipment. Be sure to connect the probe ground wire to the ground point of the circuit.

⚠ Maximum input voltage of the analog input

Category I 300Vrms, 400Vpk.

2.12 Use Auto

Once the oscilloscope is properly connected and a valid signal is input, tap the Auto Set button to quickly configure the oscilloscope to be the best display effects for the input signal. While the oscilloscope in auto state, the Auto Set button will light up.

Auto is divided into **Auto Set** and **Auto Range**. It is defaulted as Auto Set.

Auto Set — Single-time auto, and each time press “Auto”, the screen displays “Auto” in the upper left corner. The oscilloscope can automatically adjust the vertical scale, horizontal scale and trigger setting according to the amplitude and frequency of signals, adjust the waveform to the appropriate size and display the input signal. After adjustments, exit from the auto set, the “Auto” in the upper left corner disappears.

Channels may be automatically opened. Any channel greater or less than the threshold level can be opened or closed automatically according to the set threshold level. The threshold level can be settable.

Source can be automatically triggered, and the triggered source channel can be automatically set to select priority to the current signal or to the maximum signal.

Open the main menu. Tap "Auto" to open the auto set menu, including channel open/close setting, threshold voltage setting and trigger source setting.



Figure 2-9 Open Auto Set

Automatic configuration includes: single channel and multiple channels; automatic adjustment of the horizontal time base, vertical sensitivity and trigger level of signal; the oscilloscope waveform is inverted off, the bandwidth

limit sets to full bandwidth, it sets as DC coupling mode, the sampling mode is normal; the trigger type is set to edge trigger and the trigger mode is automatic.

Note: The application of Auto Set requires that the frequency of measured signal is no less than 20Hz, the duty ratio is greater than 1% and the amplitude is at least 2mVpp. If these parameter ranges are exceeded, Auto Set will fail.

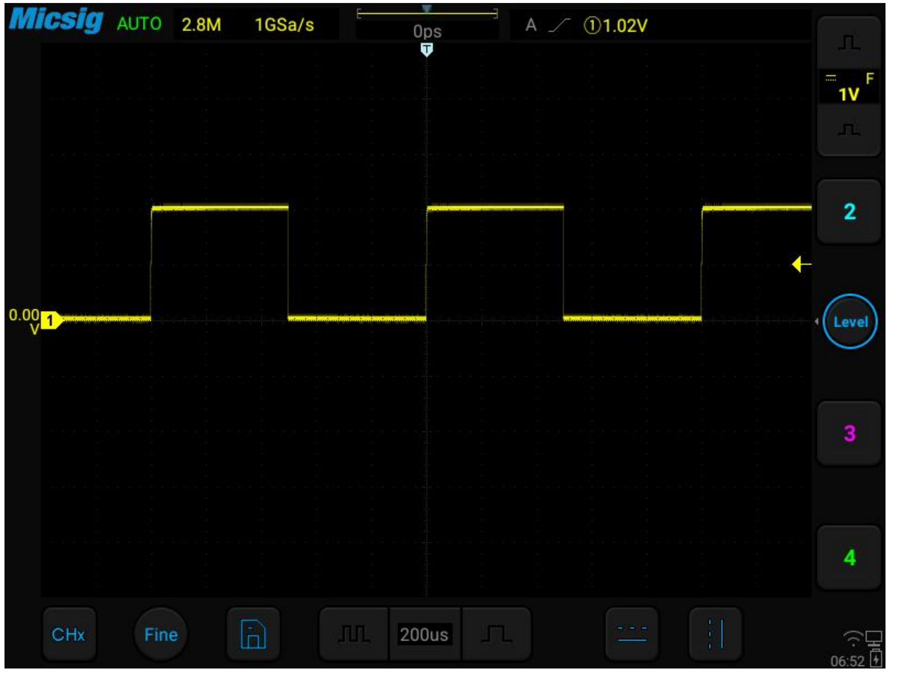


Figure 2-10 Auto Set Waveform

Auto Range - Continuously automatic, the oscilloscope continuously adjusts the vertical scale, horizontal time base and trigger level in a real-time manner according to the magnitude and frequency of signal. It is defaulted as off and needs to be opened in the menu. This function is mutually exclusive with "Auto Set".

Open the main menu and tap "Auto" to open the auto range menu for the corresponding settings. When the oscilloscope auto range function is turned on, the oscilloscope will automatically set various parameters, including: vertical scale, horizontal time base, trigger level, etc. When the signal is connected, these parameters will automatically change, and the signal does not need to be operated again after the change. The oscilloscope will automatically recognize and make the appropriate changes.

- Auto range: Turn the auto range function on or off
- Vertical scale: Turn on the vertical scale automatic adjustment function;
- Horizontal time base: Turn on the horizontal time base automatic adjustment function;
- Trigger level: Turns on the auto-adjust trigger level function.

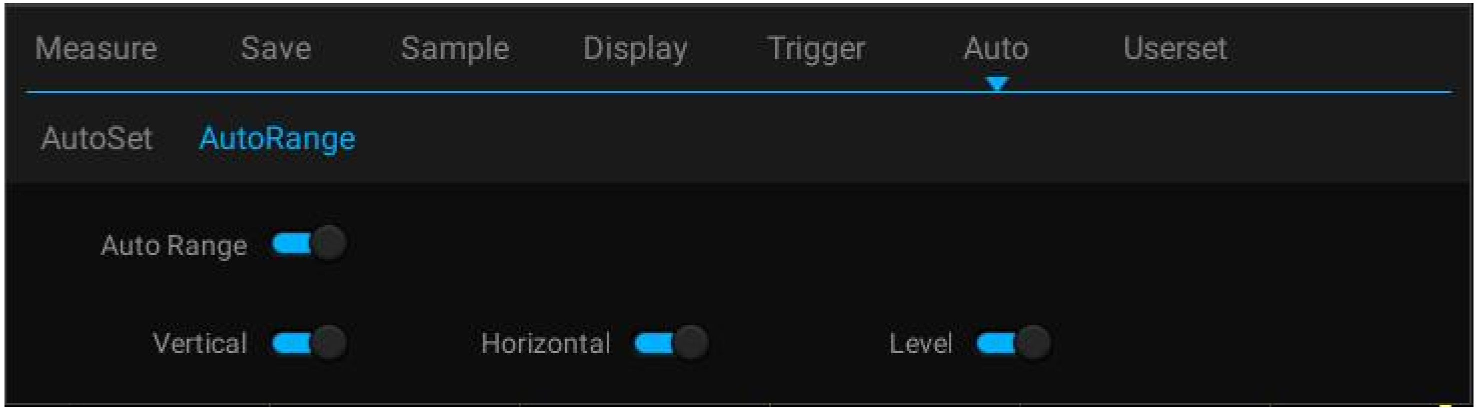


Figure 2-11 Open Auto Range

Auto Range is usually more useful than Auto Set under the following situations:

1) It can analyze signals subject to dynamic changes.

2) It can quickly view several continuous signals without adjusting the oscilloscope. This function is very useful if you need to use two probes at the same time, or if you can only use the probe with one hand because the other hand is full.

3) Control the automatic adjustment setting of the oscilloscope.

2.13 Load Factory Settings

Open the main menu, tap “User Settings” to enter the user setting page. Tap “Factory Settings” and the dialog box for loading factory settings will pop-up. Press “OK” and load the factory settings. The dialog box for loading factory settings is shown in Figure 2-12.

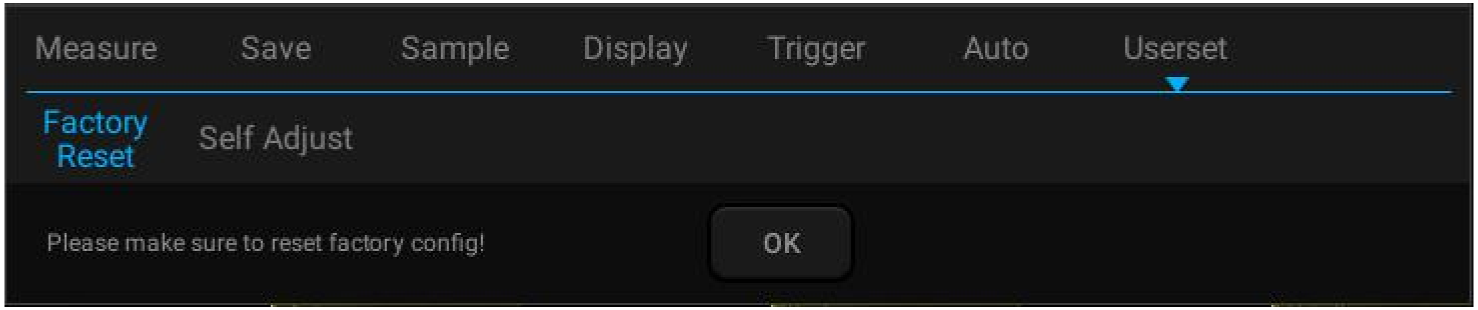


Figure 2-12 Load Factory Settings

2.14 Use Auto-calibration

Open the main menu, tap “User Settings” to enter the user setting page. Tap “Auto Calibration” to enter the auto-calibration mode. When the auto-calibration function is active, the upper left corner of the screen displays

“Calibrating” in red, and after calibrating is finished, the word in red disappears. When the temperature changes largely, the auto-calibration function can make the oscilloscope maintain the highest accuracy of measurement.

- Auto-calibration should be done without probe.
- Auto-calibration process takes about two minutes.
- If the temperature changes above 10℃, we recommended users perform the auto-calibration.

2.15 Passive Probe Compensation

Before connecting to any channels, users should make a probe compensation to ensure the probe match the input channel. The probe without compensation will lead to larger measurement errors or mistakes. Probe compensation can optimize the signal path and make measurement more accurate. If the temperature changes 10℃ or above, this program must run to ensure the measurement accuracy.

Probe compensation may be conducted in the following steps:

1) First, connect the oscilloscope probe to CH1. If a hook head is used, make sure that it is in good connection with the probe.

2) Connect the probe to the calibration output signal terminal and connect the probe ground to the ground terminal.

   As shown in Figure 2-13.



Figure 2-13 Probe Connection

3) Open the channel (if the channel is closed).

4) Adjust the oscilloscope channel attenuation coefficient to match the probe attenuation ratio.

5) Tap Auto button or manually adjust the waveform vertical sensitivity and horizontal time base. Observe the shape of the waveform, see Figure 2-14.

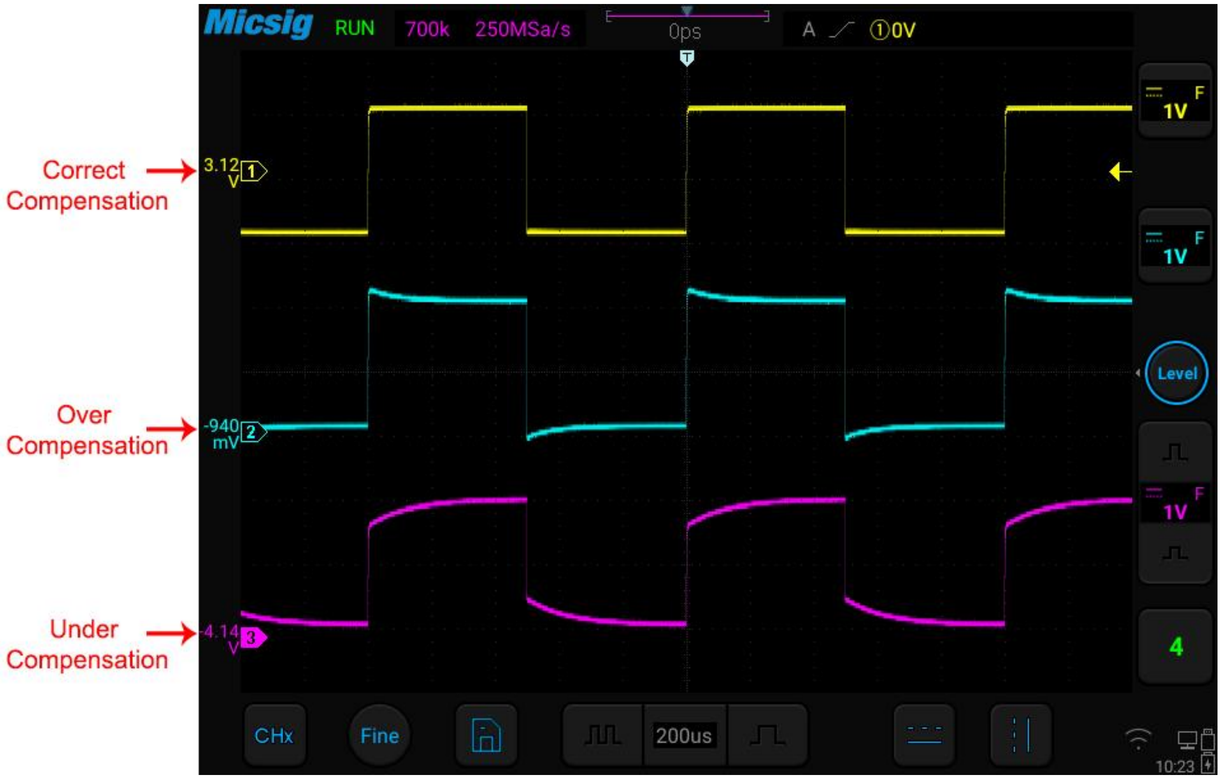


Figure 2-14 Probe Compensation

If the waveform on the screen is shown as “under-compensation” or “over-compensation”, please adjust the trimmer capacitor until the waveform shown on the screen as “correct-compensation”. The probe adjustment is shown in Figure 2-15.



Figure 2-15 Probe Adjustment

The safety ring on the probe provides a safe operating range. Fingers should not exceed the safety ring when using the probe, so as to avoid electric shock.

6) Connect the probe to all other oscilloscope channels (Ch2 of a 2-channel oscilloscope, or Ch 2, 3 and 4 of a 4-channel oscilloscope).

7) Repeat this step for each channel.

⚠**Warning**

- *Ensure the wire insulation is in good condition to avoid probe electric shock while measuring high voltage.*
- *Keep your fingers behind the probe safety ring to prevent electric shock.*
- *When the probe is connected a voltage source, do not touch metal parts of the probe-head to prevent electric shock.*
- *Before any measurement, please correctly connect the probe ground end.*

2.16 Modify the Language

To modify the display language, please refer to "13.3 Settings - Language and Input Method".

Chapter 3 Operate the Oscilloscope with Buttons

This chapter contains operating details of the oscilloscope with buttons. The button areas can be used to either operate oscilloscope without touch screen, or used with the touch screen. You are recommended to read this chapter carefully to understand the operation of buttons of the Smart series oscilloscope.

- Function buttons
- Multi-function area
- Cursor
- Vertical system
- Horizontal system
- Trigger system
- Home page, screen lock



Figure 3-1 Button Areas

3.1 Function Buttons

Auto

Use 

on the right function button area to turn on the Auto Set function. Each time you press “Auto”, the oscilloscope can recognize the type of input signal and adjust the control mode. It automatically adjusts the vertical scale, horizontal scale and trigger settings. Adjust to the waveform to the best display state.

For details, please refer to “2.11 Use Auto” in Chapter 2.

Run/Stop and Single SEQ

Press 

to quickly freeze and capture the current signal waveform, and click again, the waveform continues to run;

Press 

for single acquisition. The oscilloscope displays the waveform acquired in a single acquisition. In the roll mode and large time base mode, the acquisition will stop at full screen.

For details, please refer to “11.2 Run/Stop and Single SEQ Buttons” in Chapter 11.

Screen capture: Press  to enable the on-screen screen capture function of the oscilloscope. Click the screen capture option for other applications.

Note: Auto, Run/Stop, Single SEQ button functions and Screen capture can also be accessed by simply clicking on the menu options in the pull-up menu.

3.2 Menu Navigation Switch

Menu opening and closing

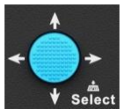
Press 

to open or close the bottom menu.

Press top 

to open or close the main menu.

Menu switching

After opening the menu, use the menu navigation switch 

to shuttle through the menu. This navigation switch is an intuitive way to add 5 button's worth of interfacing with a single component. Inside is 5 switches: left,

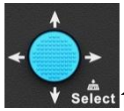
right, up, down, and 'select' (pressing down). Press to select the menu and automatically enter the next menu. Press  to return to the previous menu.

3.3 Cursor

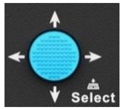
- Cursor on and off: Press 

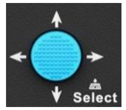
button to turn on the horizontal cursor, press 

button to turn on the vertical cursor.

- Cursor linkage: Press the 

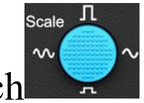
to enter the cursor linkage.

- Cursor movement: Left & right switch 

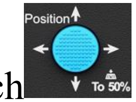
to adjust the X1 or X2 cursor, up & down switch 

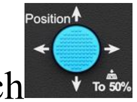
to adjust the Y1 or Y2 cursor;

3.4 Horizontal System

Adjust the horizontal time base: In the horizontal adjustment area, Left & right scale navigation switch

to adjust the horizontal time base of all analog channels (current channels).

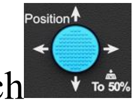
Adjust the horizontal position: In the horizontal adjustment area, Left & right position navigation switch

to move the waveform horizontal position of all analog channels. Press the position navigation switch

to move the trigger position of all analog channels (current) to the center of the horizontal direction.

Press 

to open or close Zoom. When Zoom is open, 

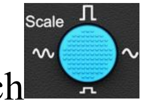
button will be on. Left & right position navigation switch

to move the horizontal position of the Zoom window. For details, please refer to "4.5 Zoom Mode" in Chapter 4.

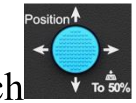
3.5 Vertical System

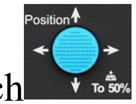
Analog Channel

Open/close: Press the analog channel button Ch1, Ch2, Ch3, Ch4, Ref, Math, to cyclically realize the functions: open the channel, switch the current channel, and close the channel. When channel is open, Ch1, Ch2, Ch3, Ch4, Ref, Math button will be on.

Adjust the vertical sensitivity: Up & down scale navigation switch 

to adjust the vertical sensitivity of the current channel so that the waveform is displayed on the screen at an appropriate size.

Adjust the vertical position: Up & down position navigation switch 

to adjust the vertical position of the current channel. Press the position navigation switch 

to move the current channel waveform to the vertical center of the screen.

Serial bus channel

Long press the Math to open S1 channel, press the bottom Menu to open S1 channel menu, long press the Math buttons again to close the S1 channel.

Long press the Ref to open S2 channel, press the bottom Menu to open S1 channel menu, long press the Ref buttons again to close the S2 channel.

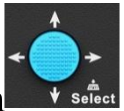
Note: The vertical system function can also be realized by simply selecting the 50% button from the menu option in the pull-up menu.

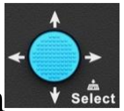
3.6 Trigger System

Adjust the trigger level: Up & down trigger navigation switch Trigger to adjust the current trigger level;

Trigger source switching: Left & right trigger navigation switch Trigger to switch the trigger source;

Adjust the trigger hold-off time: Open the trigger hold-off time adjustment frame, as shown in the figure below.

Left & right menu navigation switch 

for coarse adjustment, up & down menu navigation switch 

for fine adjustment.

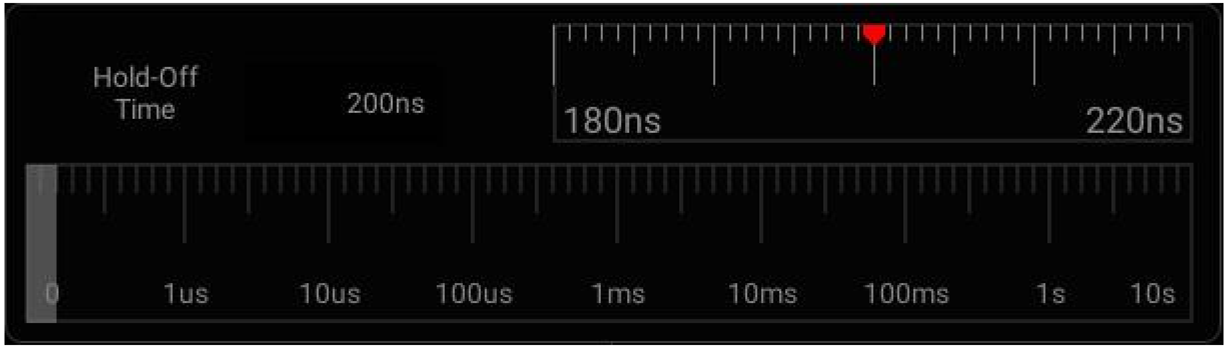
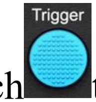


Figure 3-2 Trigger hold-off time

Bus threshold level adjustment and switching: After opening the serial bus channel, long press trigger navigation switch 

to switch between bus threshold level and trigger level.

For details, please refer to "Chapter 6 Trigger System".

3.7 Homepage, Screen Lock

Home: Press , switch to the oscilloscope homepage. For details, please refer to "Chapter 13 Homepage Functions".

Screen lock: Press make touch screen function of the oscilloscope fails, and the button light is on.

Note: The Home button function can also be accessed by simply clicking on the menu option in the pull-up menu.

Chapter 4 Horizontal System

This chapter contains the detailed information of the horizontal system of the oscilloscope. You are recommended to read this chapter carefully to understand the set functions and operation of the horizontal system of the Smart series oscilloscope.

- Move the waveform horizontally

- Adjust the horizontal time base (time/div)
- Pan and zoom single or stopped acquisitions
- Roll, XY
- Zoom mode

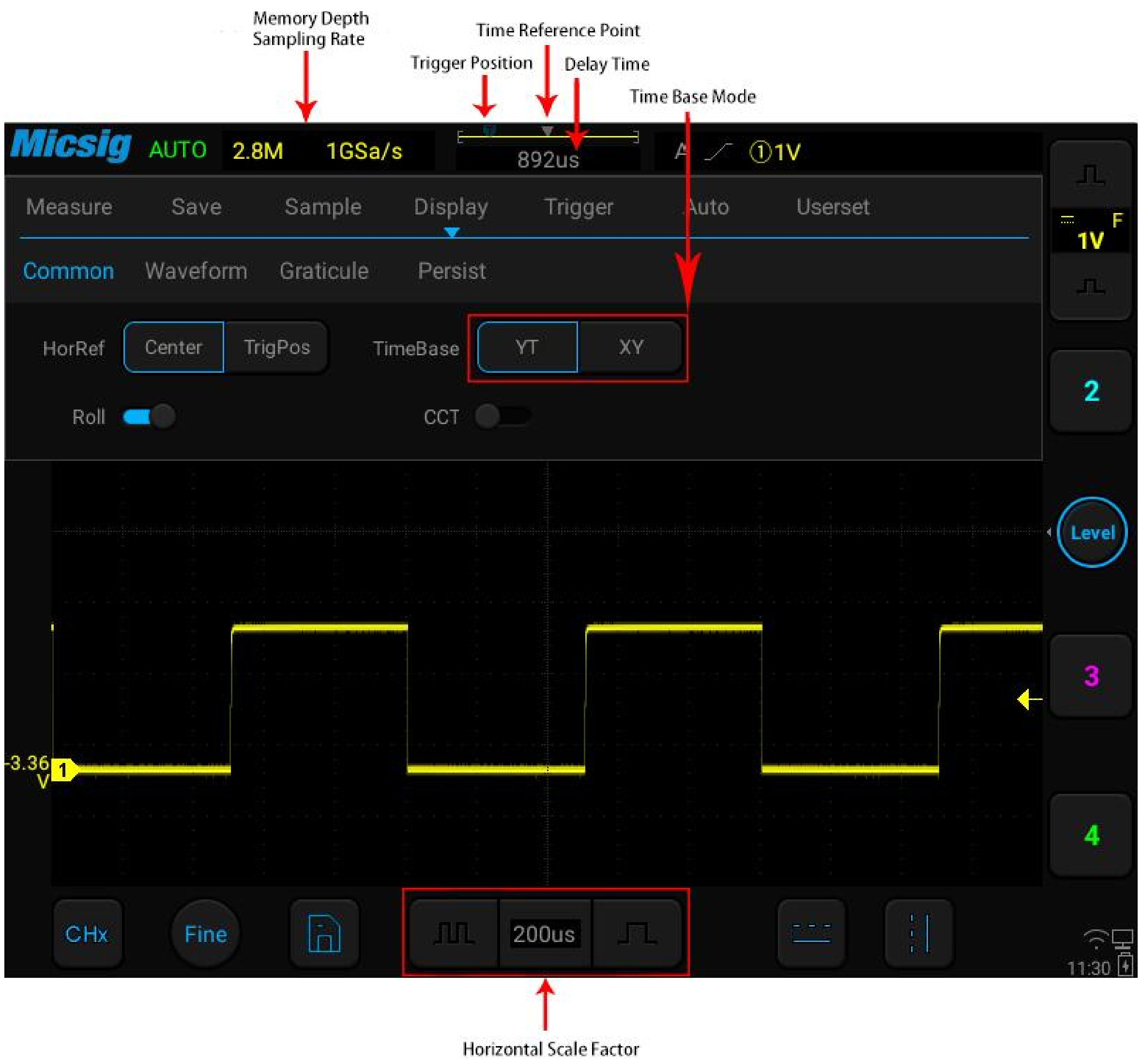


Figure 4-1 Horizontal system

4.1 Move the Waveform Horizontally

Put one finger on the waveform display area to swipe left and right, for the coarse adjustment of the waveform position horizontally of all analog channels; after moving the waveform, tap the fine adjustment button in the lower left corner of the screen for fine adjustment.

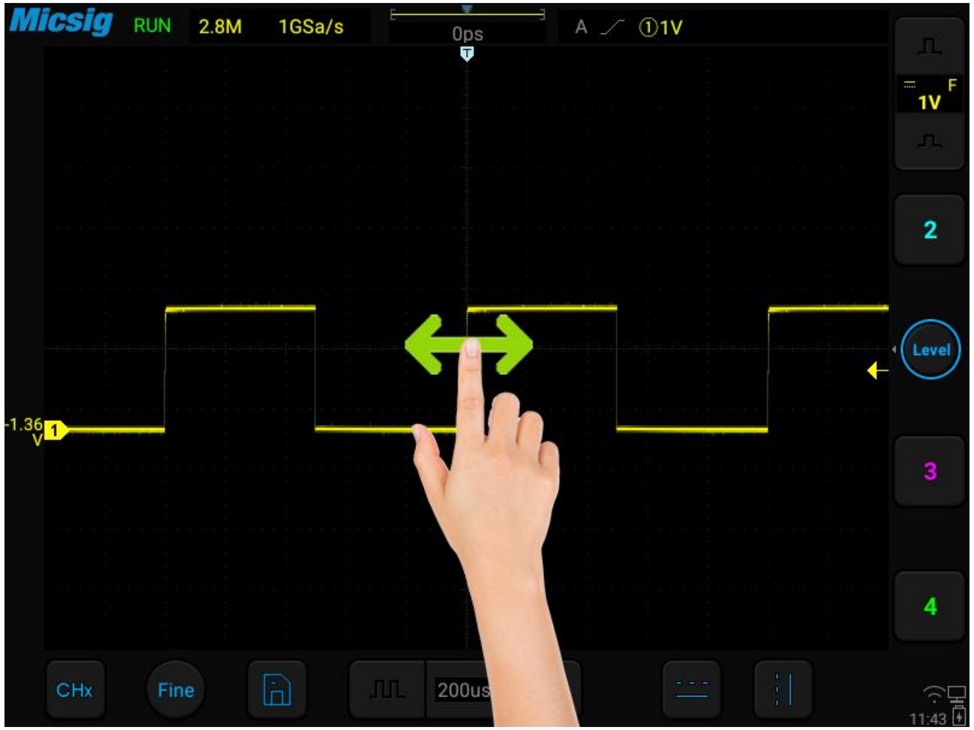


Figure 4-2 Move the Waveform Horizontally on the Screen

4.2 Adjust the Horizontal Time Base (time/div)

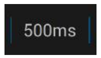
Method 1: Soft Keys

Tap ,  buttons to adjust the horizontal time base of all analog channels (current channels). Tap  button to increase the horizontal time base; tap  button to zoom out the horizontal time base (see Figure 4-3 Adjust the Horizontal Time Base). The horizontal time base is stepped in 1-2-5, while the waveform changes as the time base changes.



Figure 4-3 Adjust the Horizontal Time Base

Method 2: Time Base Knob

Tap 

 to open the time base list (see Figure 4-4 Horizontal Time Base List), then tap the list to select the appropriate time base. The time base with the blue filled background is the currently selected time base.

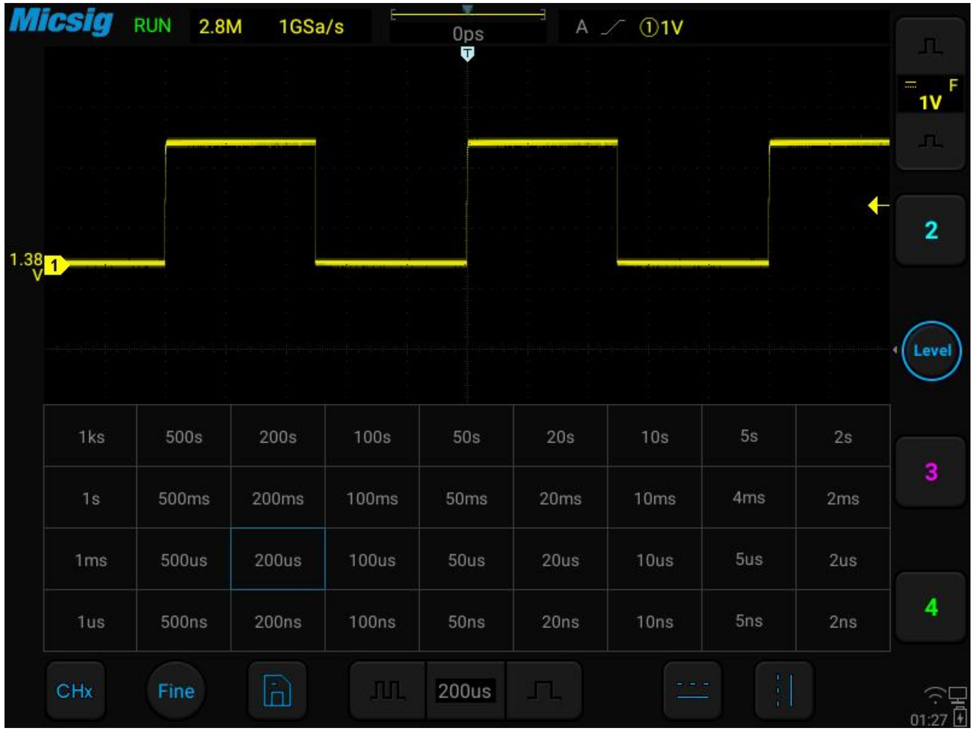


Figure 4-4 Horizontal Time Base Knob

4.3 Pan and Zoom Single or Stopped Acquisitions

After the oscilloscope is stopped, the stopped display screen may contain several acquired data with useful information, but only the data in the last acquisition can be horizontally moved and zoomed. The data of the single

acquisition or stopped acquisition is moved horizontally and zoomed. For details, refer to "4.1 Move the Waveform Horizontally" and "4.2 Adjust the Horizontal Time Base (time/div)".

4.4 Roll, XY

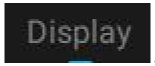
In the main menu, tap the soft key , then select the desired time base mode. The time base mode is divided into YT, ROLL, and XY.



Figure 4-5 Display Mode

YT——Normal View Mode of Oscilloscope

In YT mode, the relative relationship between vertical voltage and horizontal time is displayed. Y axis represents the voltage, X axis represents the time, and the waveform is displayed after triggering (waveform displayed from left to right).

Note: When the time base is large (such as 200ms and above), sometimes the waveform will not be displayed for a long time; this is because in YT mode, the waveform must be triggered before display. It is closely related to the time base and can be roughly calculated as: the number of divisions on the left side of the trigger position * time base level position; if you want to reduce the waiting time, move the trigger position to the left.

The case that trigger position is moved out of the waveform screen is not considered here.

ROLL—— ROLL Mode

In ROLL mode, the waveform rolls from right to left to refresh the display (see Figure 4-6 ROLL Mode). The horizontal time base adjustment range of the ROLL mode in the running state is 200ms/div~1ks/div.

In ROLL mode, trigger related information is invalid, including trigger position, trigger level, trigger voltage, etc.

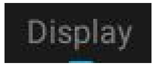


Figure 4-6 ROLL Mode

In ROLL mode, press Run/Stop to stop waveform display; press Run/Stop again to clear waveform display and restart acquisition; press SEQ to execute single sequence, it will stop automatically after completing a full screen acquisition.

ROLL mode is generally used to observe waveforms with frequencies below 5 Hz.

ROLL mode is defaulted as open. When the time base is greater than 100ms, it automatically enters the ROLL mode. If the signal to be triggered under a large time base needs to be viewed, turn off the ROLL mode.

Roll mode on and off: In the main menu, tap the soft key 

. In the "Common" option, you can turn the roll mode on and off (refer to Figure 4-7). When the roll mode is on and the time base is within 200ms~1ks, the oscilloscope automatically enters the roll mode.



Figure 4-7 Roll Mode On/Off

XY——XY Mode

The vertical amount of CH1 is displayed on the horizontal axis in XY mode, and the vertical amount of CH2 is displayed on the vertical axis (see Figure 4-8 XY Mode).

You can use XY mode to compare the frequency and phase relationship of two signals.

XY mode can be used for sensors to display stress-displacement, flow-pressure, voltage-frequency or voltage-current, for example: plotting a diode curve.

You can also use the cursor to measure the waveform in XY mode.

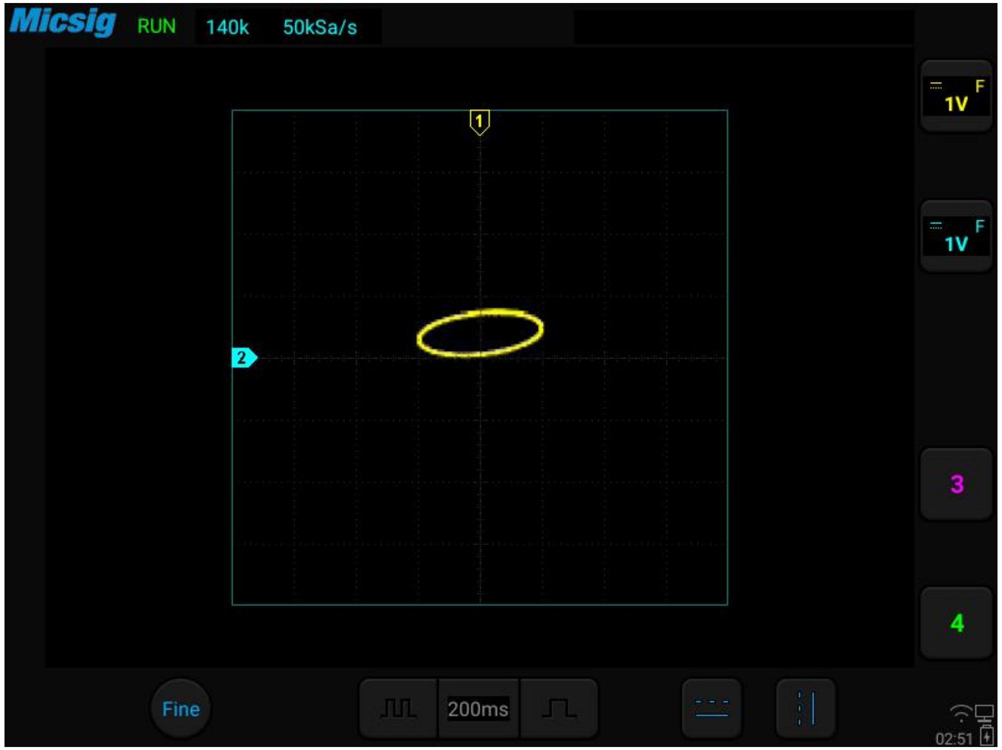


Figure 4-8 XY Mode

XY Mode Example

This exercise shows the usual practice of XY display mode by measuring the phase difference between two signals of the same frequency using the Lissajous method.

1) Connect sine wave signals to CH1 and connect sine wave signals of the same frequency and different phases to CH2.

2) Press “Auto” set button, tap “Display” in the main menu, then select “XY” in “Time Base”.

3) Drag signals so that they are centered on the display screen. Adjust the vertical sensitivity of CH1 and CH2, and extend signals for viewing.

The phase difference (θ) can be calculated using the following formula (assuming that the amplitudes of the two channels are the same):

$$\sin\theta = \frac{A}{B} \text{ or } \frac{C}{D}$$

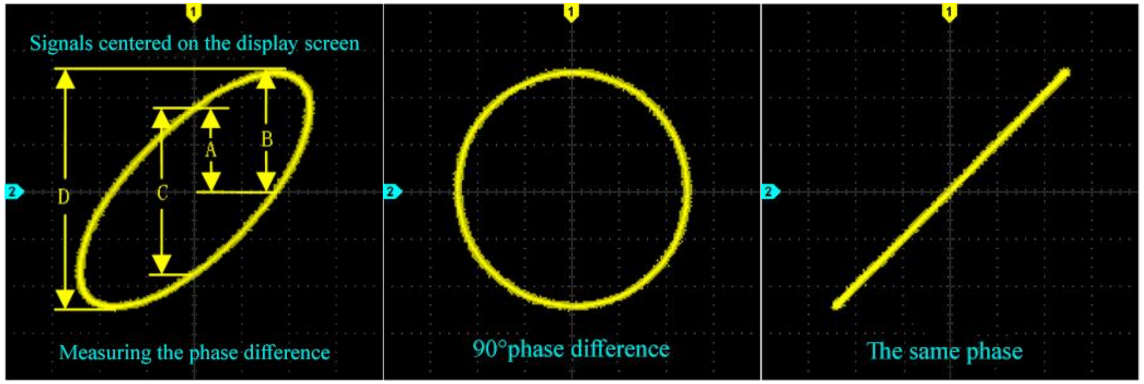


Figure 4-9 XY Time Base Mode Signal, Center on the Display Screen

4) Tap the "Cursor" button to open the horizontal cursor.

5) Set the cursor y2 at the top of the signal and the cursor y1 at the bottom of the signal. Record the Δy value in the upper right corner of the screen.

6) Move y1 and y2 cursors to the intersection point of the signal and the y-axis. Record the Δy value again.

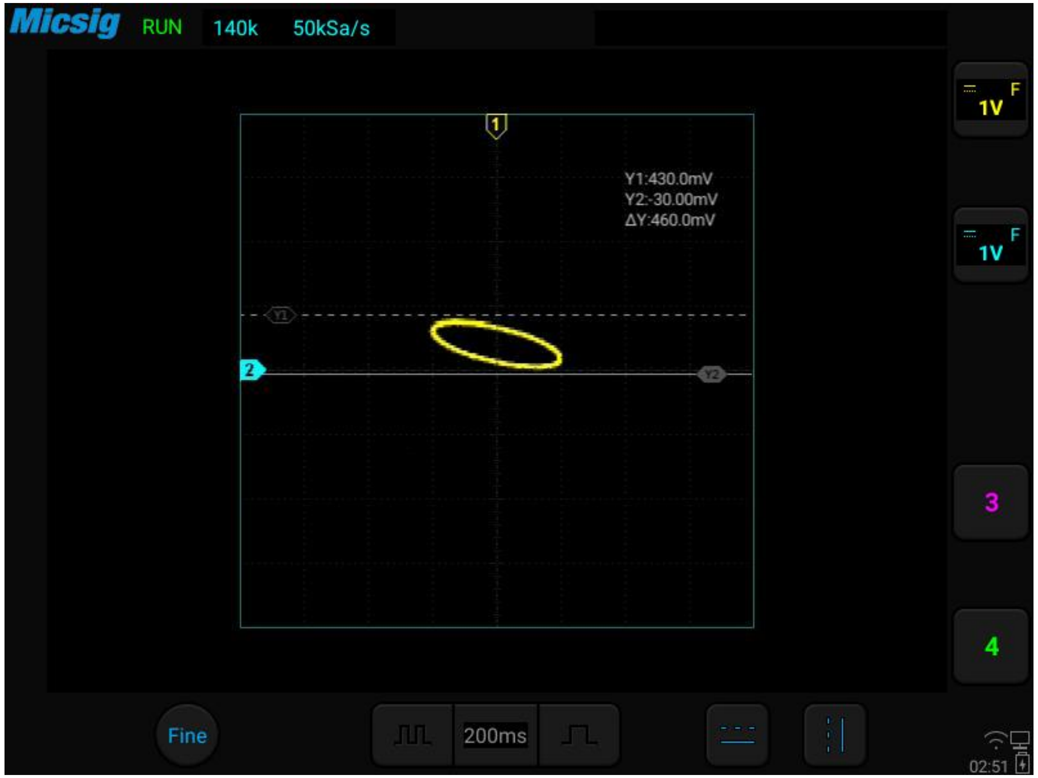


Figure 4-10 Phase Difference Measurement and Using the Cursor

7) The following formula is used to calculate the phase difference.

$$sin\theta = \frac{Y2}{Y1}; \quad \theta = arcsin\frac{Y2}{Y1}$$

For example, if the first Δy value is 9.97V, the second Δy value is 5.72V:

$$sin\theta = \frac{5.72}{9.97};\quad \theta = arcsin\frac{5.72}{9.97}$$

4.5 Zoom Mode

Zoom is a horizontally expanded version of the normal display. Open the zoom function, the display is divided into two parts (see Figure 4-11 Zoom Interface). The upper part of the display screen shows the normal display window view and the lower part shows the zoomed display window.

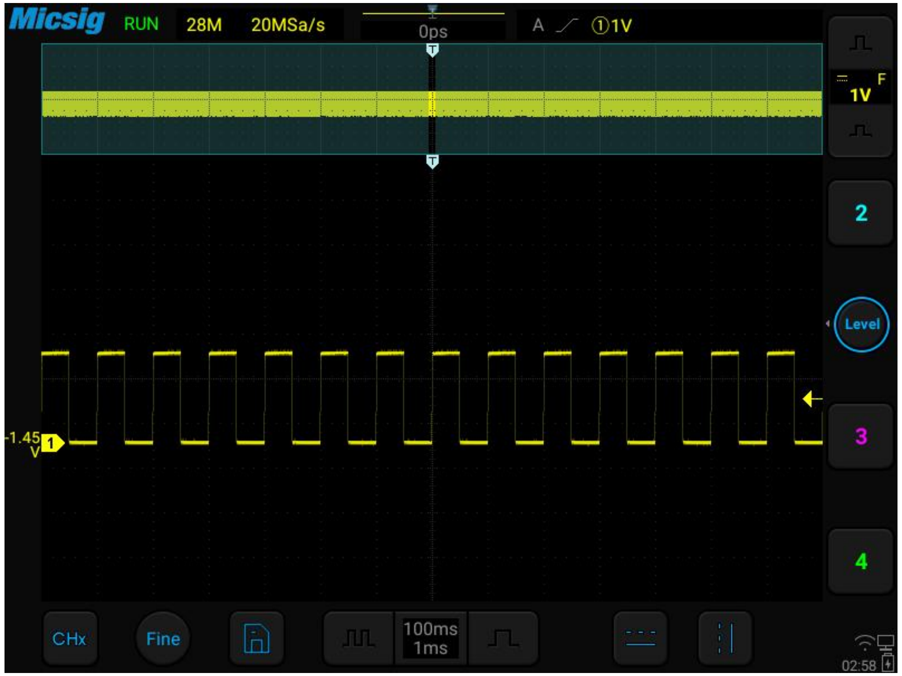


Figure 4-11 Zoom Interface

Zoom window view is the enlarged portion of the normal display window. You can use “Zoom” to view a portion of the normal window that is horizontally expanded to learn more about signal analysis.

Zoom on/off:

Open the pull-up menu and tap 

button to turn the zoom function on/off.

Zoom window is framed in a box on the normal window, and the other portion is covered by gray shade not displayed in the zoom window. This box shows the normal scan portion that was zoomed in the lower bottom.

Tap the time base button to adjust the time base of the zoom window. The size of the box in the normal window changes according to the time base of the zoom window.

Drag the waveform of the zoom window horizontally to adjust the waveform position. The box in the main window moves oppositely against the waveform; or directly drag the box in the normal window to quickly locate the waveform to be viewed.

Note:

1) The minimum time base is displayed in the normal window when the waveform in the screen is exactly within the memory depth. If the current time base is smaller than the minimum time base in the normal window at the current memory depth, when the zoom window is opened, the time base in the normal window is automatically set to the minimum time base in the normal window at the current memory depth.

2) The cursor, math waveform, and reference waveform are not displayed in the normal window, but can be displayed in the Zoom window.

3) If Roll mode is stopped, Zoom mode can be turned on, and tap “Run/Stop” to automatically turn off Zoom mode.

Chapter 5 Vertical System

This chapter contains the detailed information of the vertical system of the oscilloscope. You are recommended to read this chapter carefully to understand the set functions and operation of the vertical system of the Smart series oscilloscope.

- Open/close channel, set the current channel
- Adjust vertical sensitivity
- Adjust vertical position
- Open channel menu
- Set channel coupling
- Set bandwidth limit
- Waveform inversion
- Set probe type
- Set probe attenuation coefficient
- Vertical expansion reference

The figure below shows the "CH1 Channel Menu" displayed after opening the CH1 channel menu.

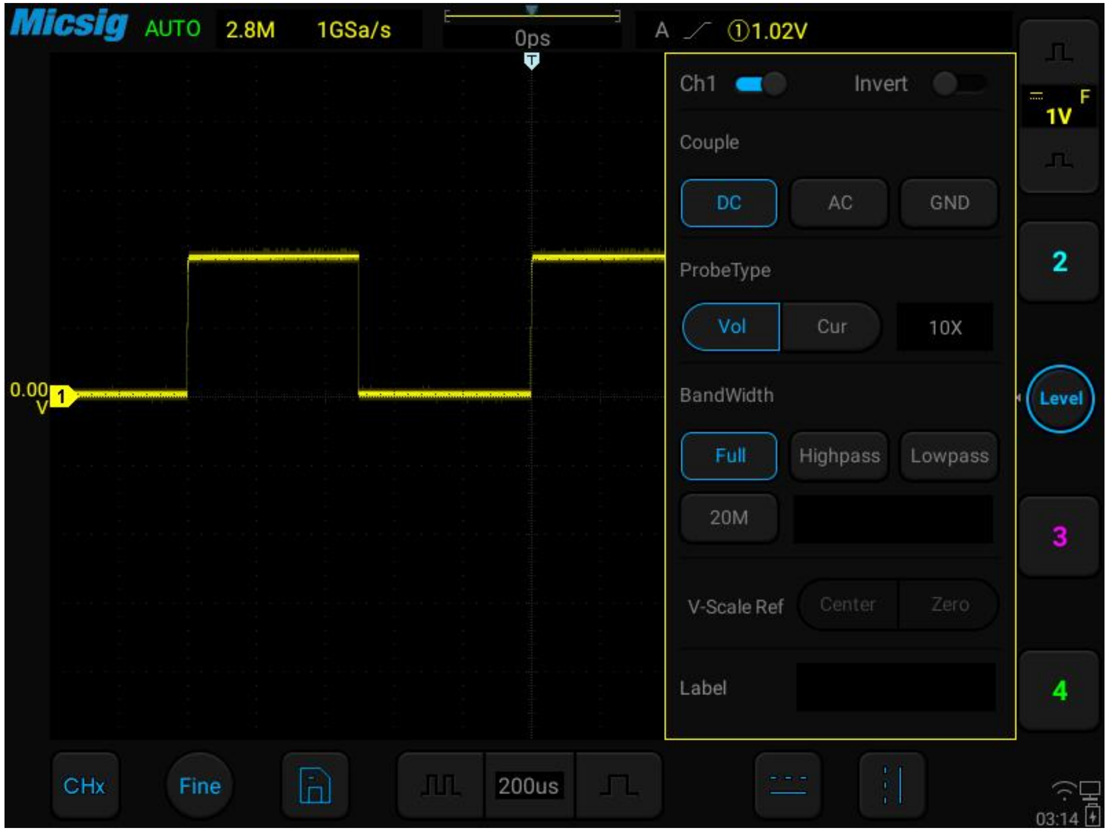


Figure 5-1 Channel Menu Display Interface

The ground level of each displayed analog channel signal is indicated by the channel indicator icon 1 on the far left of the display screen.

5.1 Open/Close Waveform (Channel, Math, Reference Waveforms)

The channel icons 

, 

, 

, 

, 



on the right side of the oscilloscope waveform display area (swipe up or down to switch to math channel and reference channel) correspond to the six channels of CH1, CH2, CH3, CH4, math function and reference channel. The channel icons in open state will shows like

, 

, 

, 

, 

, 

. Swipe right to close the desired channel.

Current channel: The oscilloscope can display multiple waveforms at the same time, but only one waveform is preferentially displayed on the uppermost layer, and the channel that is preferentially displayed on the uppermost layer is called the current channel. The channel indicator for the current channel is solid, and the channel indicator for the non-current channel is hollow, as shown in Figure 5-2.



Figure 5-2 Current Channel and Non-Current Channel

The display content of the oscilloscope channel display interface includes the vertical scale, vertical scale sensitivity button, coupling mode, invert, bandwidth limitation of the channel, as shown in Figure 5-3.

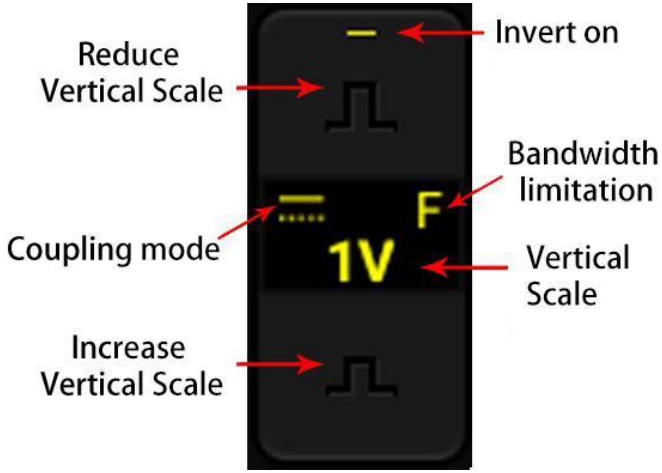


Figure 5-3 Channel Display Interface

When CH1 is on, but the state is not the current channel, tap CH1 waveform or vertical sensitivity or channel indicator 1 or vertical sensitivity button or current channel selection button to set CH1 as the current channel, as shown in Figure 5-4.



Figure 5-4 Channel Open, Close and Switching

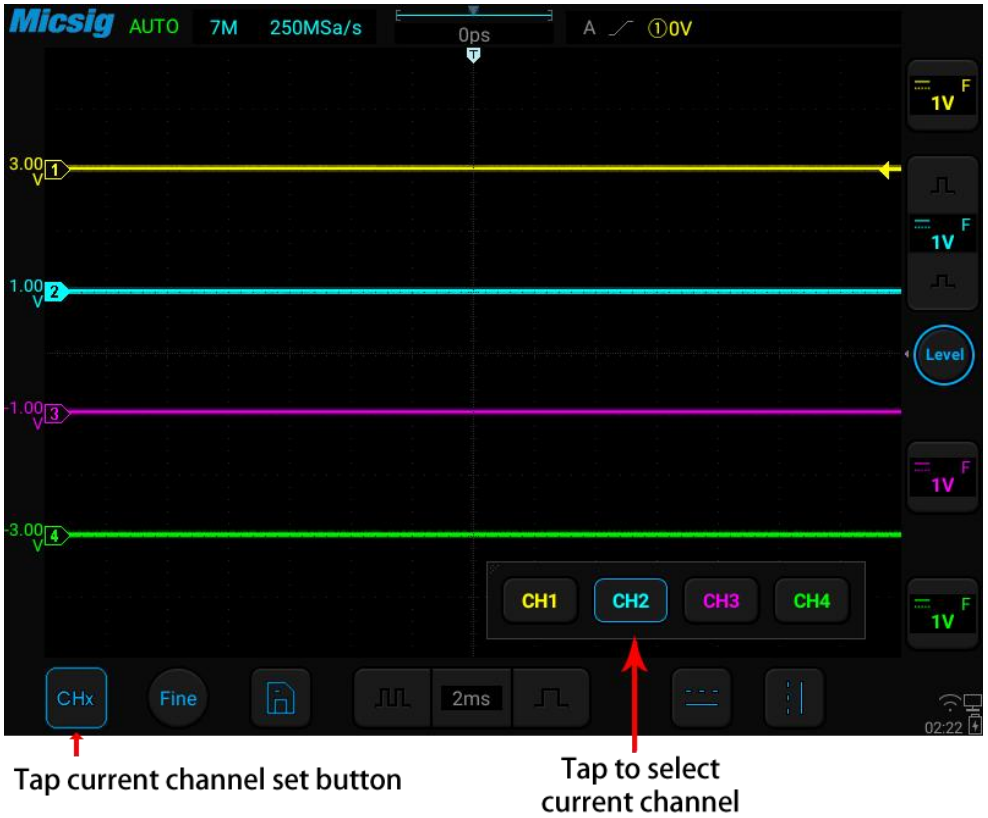


Figure 5-5 Using the Current Channel Selection Button

Tap the current channel icon at the bottom of the screen to pop up the current channel switching menu and press the button to light it up, as shown in Figure 5-5. Tap the button in the menu to switch the current channel. When this function is opened:

a. the current channel may be switched in the channel switching menu;

b. the current channel menu can be moved anywhere on the screen;

c. only the open channel is displayed in the channel switching menu;

d. when the math or reference waveform is opened, the current channel switching menu is automatically opened.

5.2 Adjust Vertical Sensitivity

Tap the vertical sensitivity  or  buttons on the right side of the channel icon to adjust the vertical display of the waveform corresponding to the channel, so that the waveform is displayed on the screen at an appropriate size.

The vertical sensitivity scale (V/div) after each adjustment is displayed on the channel icon. For example, 

means that the current vertical sensitivity of CH1 is 1.0V/div.

The vertical sensitivity coefficient adjusts the vertical sensitivity of the analog channel in steps of 1-2-5 (the probe attenuation coefficient is 1X), and the vertical sensitivity range of 1:1 probe is 1mV/div-10V/div (optionally minimum at 500uV/div).

5.3 Adjust Vertical Position

The method of adjusting vertical position is as follows:

1) Coarse adjustment: In the waveform display area, hold the waveform and put one finger to slide up and down for changing the vertical position of the waveform.

2) Fine adjustment: Click the fine adjustment button in the lower left corner of the screen to fine adjust the vertical position of the waveform for the current channel.

5.4 Open Channel Menu

Right swipe the channel icon to open the desired channel menu.

The channel menu is shown in Figure 5-6. Channel waveform inversion, channel bandwidth limit, probe type, probe attenuation factor, channel coupling mode, vertical expansion reference, channel label and channel on/off can be set in the vertical menu.

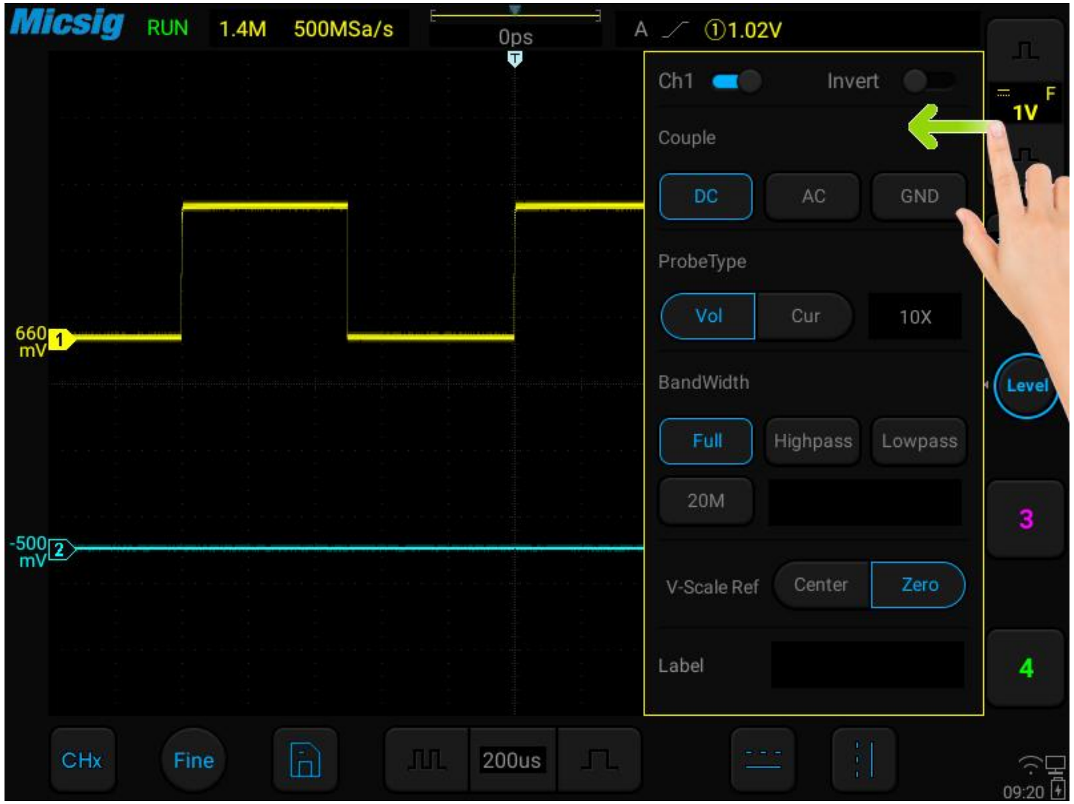


Figure 5-6 Channel menu

5.4.1 Set Channel Coupling

Tap the icon under “Coupling Mode” and select “DC”, “AC” and “GND” channel coupling modes in the pop-up box.

DC: DC coupling. Both the DC component and the AC component of the measured signal can pass, and can be used to view waveforms as low as 0 Hz without large DC offset.

AC: AC coupling. Measured DC signal is blocked, and only the AC component can be allowed to pass, and used to view waveforms with large DC offsets.

GND: Internal input ground, disconnecting from external input.

The oscilloscope is connected to the square wave signal with a frequency of 1KHz, an amplitude of 2V and an offset of 1V. The waveforms of the channel couplings of DC, AC, and GND are shown in Figures 5-7, 5-8, and 5-9.

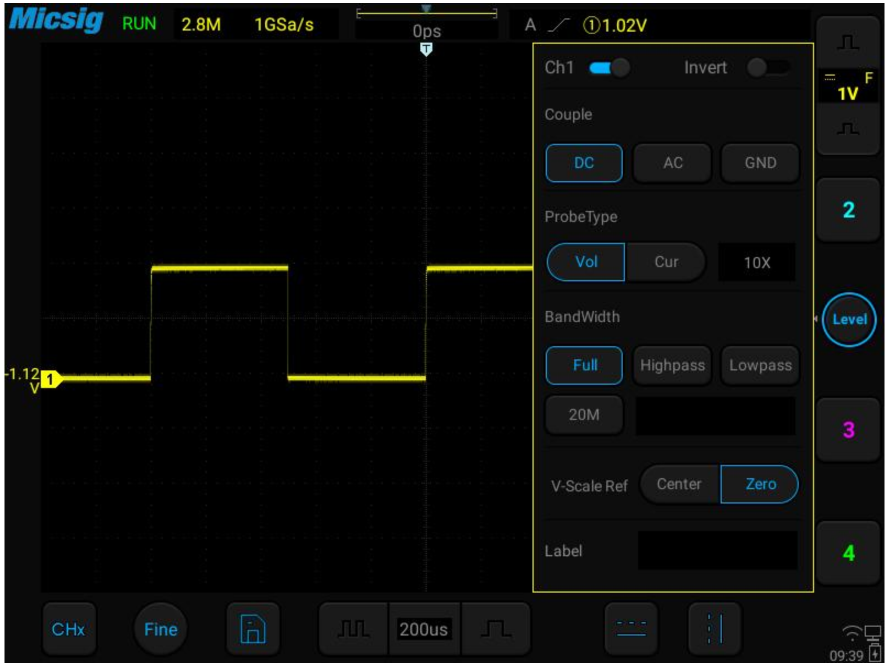


Figure 5-7 DC Coupling

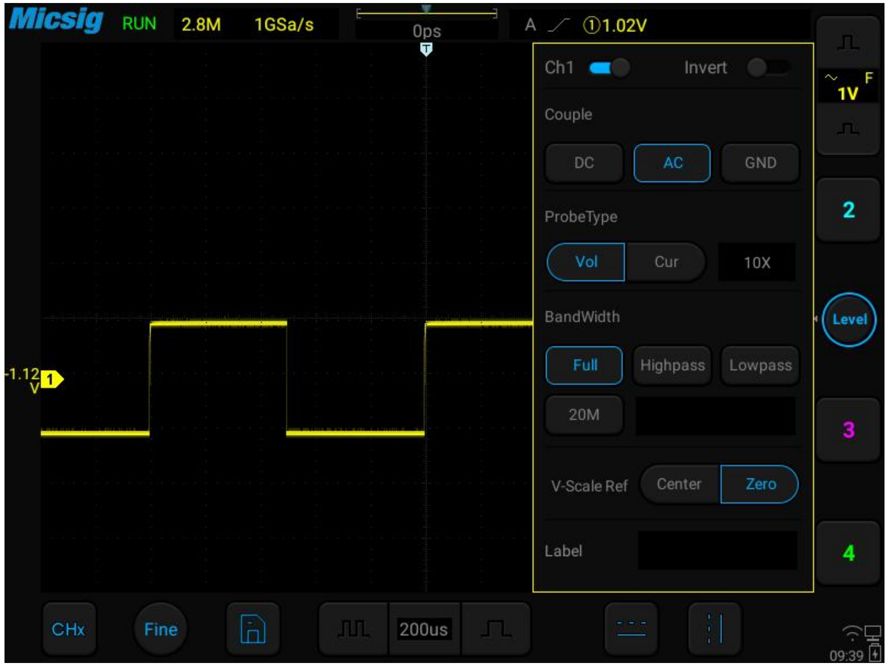


Figure 5-8 AC Coupling



Figure 5-9 GND Coupling

Note: This setting is only valid for the current channel. To switch from the current channel, just tap the channel icon, channel indicator icon or horizontal position pointed by the channel indicator icon for direct switching. You do not need to exit the menu.

5.4.2 Set Bandwidth Limit

Open the channel menu, find the “Bandwidth” selection box in the channel menu, set bandwidth limit, high-pass filtering and low-pass filtering as needed.

Full Bandwidth: Allows signals of all frequencies to pass.

20M Bandwidth: Only signals with frequencies below 20MHz are allowed to pass, and signals above 20MHz are effectively attenuated.

High Pass: Only signals above the lower limit of the currently set frequency are allowed to pass.

Select high pass, tap the frequency box 16.000MHz, open the frequency setting interface, tap “MHz” and “KHz” to select the frequency scale, drag or tap the slide bar for coarse adjustment of the maximum frequency allowed to pass, tap “+”, “-” buttons to precisely adjust the frequency.

Low pass: Only signals below the currently set frequency upper limit are allowed to pass. (with the settings same as High Pass)

High-pass filtering and low-pass filtering can be set within the frequency range of 30kHz-100MHz.

The difference in bandwidth limitation can be visualized by the waveform. The full bandwidth is shown in Figure 5-10, the 20M bandwidth is shown in Figure 5-11, the high pass is shown in Figure 5-12, and the low pass is shown in Figure 5-13.

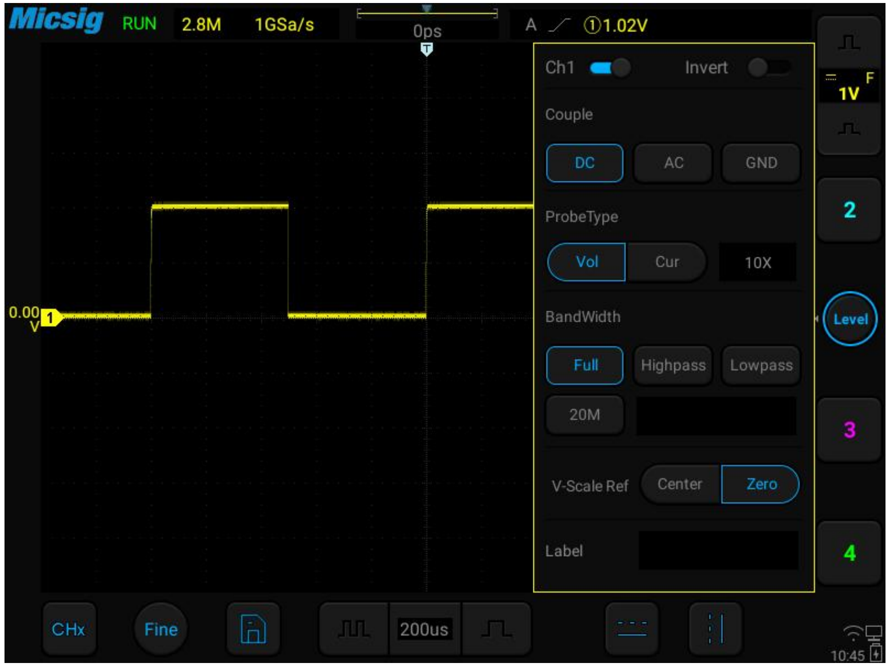


Figure 5-10 Full Bandwidth

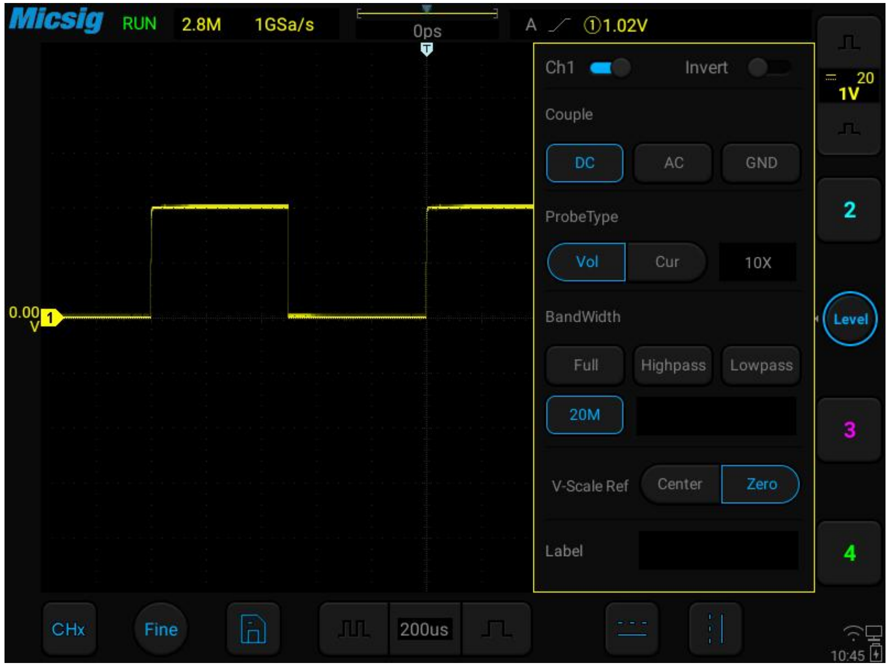


Figure 5-11 20M Bandwidth

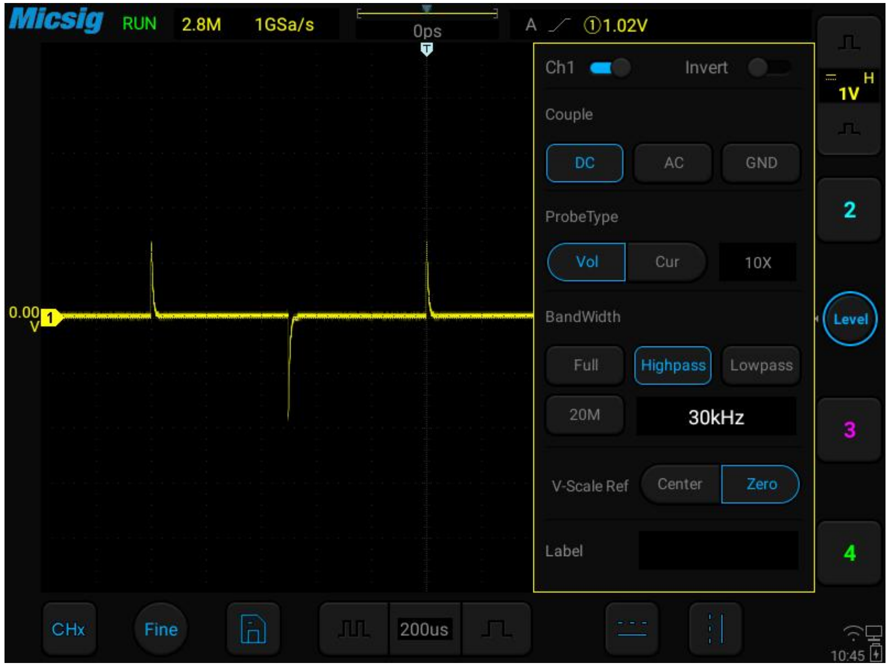


Figure 5-12 High Pass

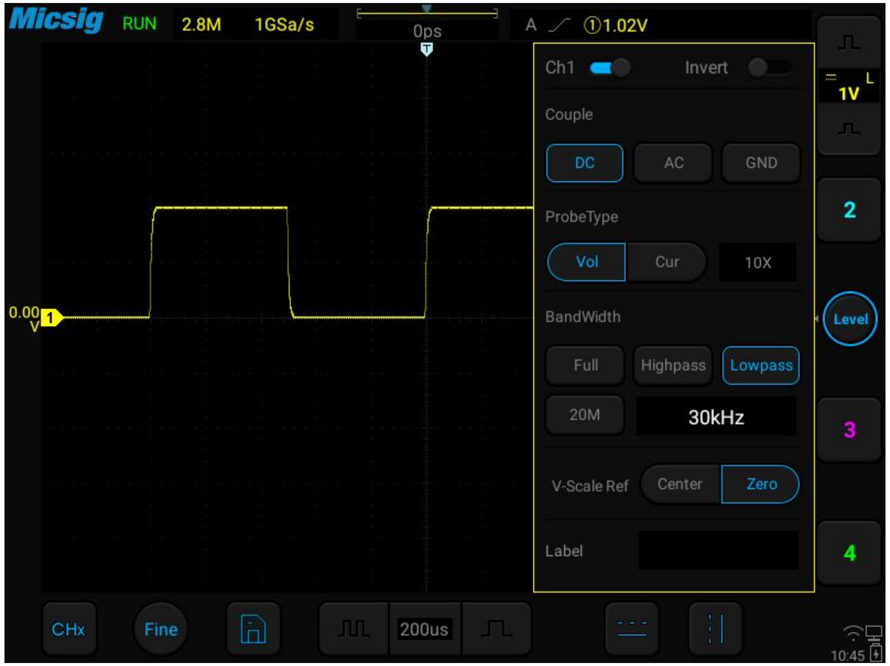


Figure 5-13 Low Pass

5.4.3 Waveform Inversion

After selecting “Invert”, the voltage value of the displayed waveform is inverted. Inversion affects the way the channel is displayed. When using a basic trigger, you need to adjust the trigger level to keep the waveform stable.

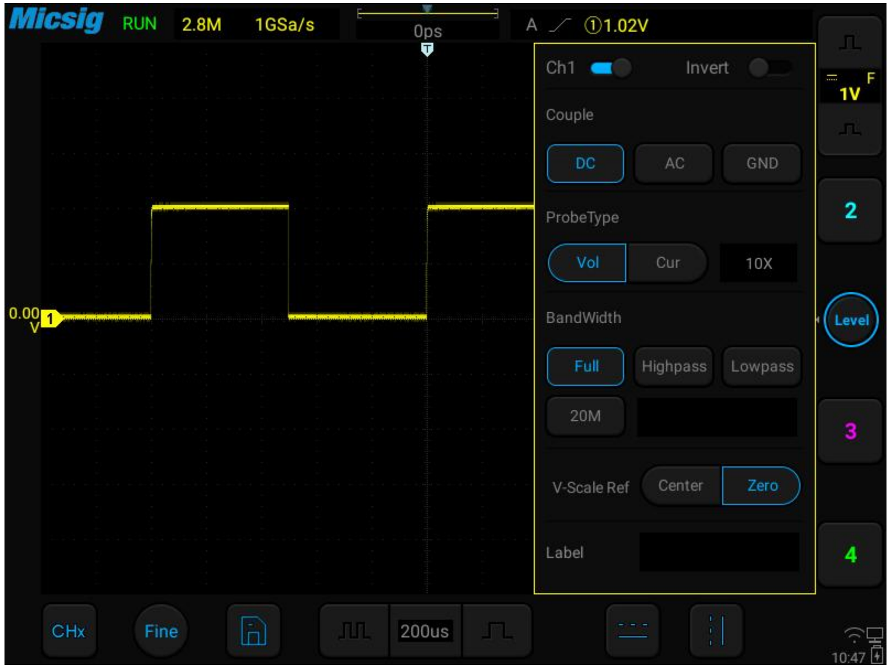


Figure 5-14 Before Inversion

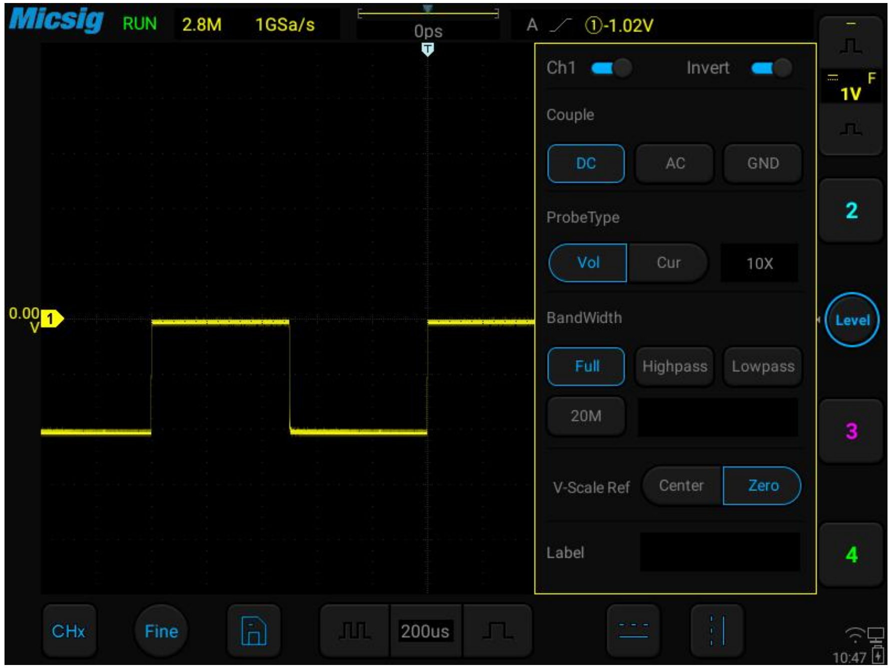
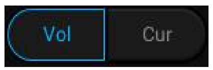


Figure 5-15 After Inversion

5.4.4 Set Probe Type

Probe types are divided into voltage probe and current probe.

Probe type adjustment steps:

Open the channel menu, find the "Probe Type" checkbox 

in the channel menu, then select:

- Vol - corresponding the voltage probe.
- Cur - corresponding the current probe.

5.4.5 Set Probe Attenuation Coefficient

When measuring with a probe, the correct measurement result can only be obtained by setting the correct probe attenuation ratio. In order to match the actual probe attenuation ratio, it is necessary to adjust the channel attenuation factor correspondingly under the channel menu. When probe attenuation ratio is changed, the corresponding attenuation ratio must be set on the channel menu to ensure the correctness of the waveform amplitude and measurement result displayed by the oscilloscope.

Probe attenuation ratio and menu attenuation ratio are shown in the table below:

Probe attenuation ratio	Probe attenuation ratio	Probe attenuation ratio	Probe attenuation ratio

Menu attenuation ratio		Menu attenuation ratio		Menu attenuation ratio		Menu attenuation ratio	
0.001:1	1mx	0.1:1	100mx	10:1	10x	1000:1	1kx
0.002:1	2mx	0.2:1	200mx	20:1	20x	2000:1	2kx
0.005:1	5mx	0.5:1	500mx	50:1	50x	5000:1	5kx
0.01:1	10mx	1:1	1x	100:1	100x	10000:1	10kx
0.02:1	20mx	2:1	2x	200:1	200x		
0.05:1	50mx	5:1	5x	500:1	500x		

Table 5-2 Probe Attenuation Ratio Correspondence Table

5.4.6 Vertical Expansion Reference

When using vertical expansion, click the center or zero point.

Center: Click the center, adjust the vertical scale, and the oscilloscope waveform is expanded with the screen center as reference

Zero point: Click the zero point, adjust the vertical scale, and the oscilloscope waveform is expanded with the waveform zero point as reference

5.4.7 Labels

Labels can be added to each analog channel as needed, and the added label is displayed behind the channel indicator.

Channel labels can be selected: none, custom, preset (including ACK, ADDR, CAN_H, CAN_L, CLK, CS, DATA, H_L, IN, L_H, MISO, MOSI, RX, SCL, SDA, SS, TX, OUT) .

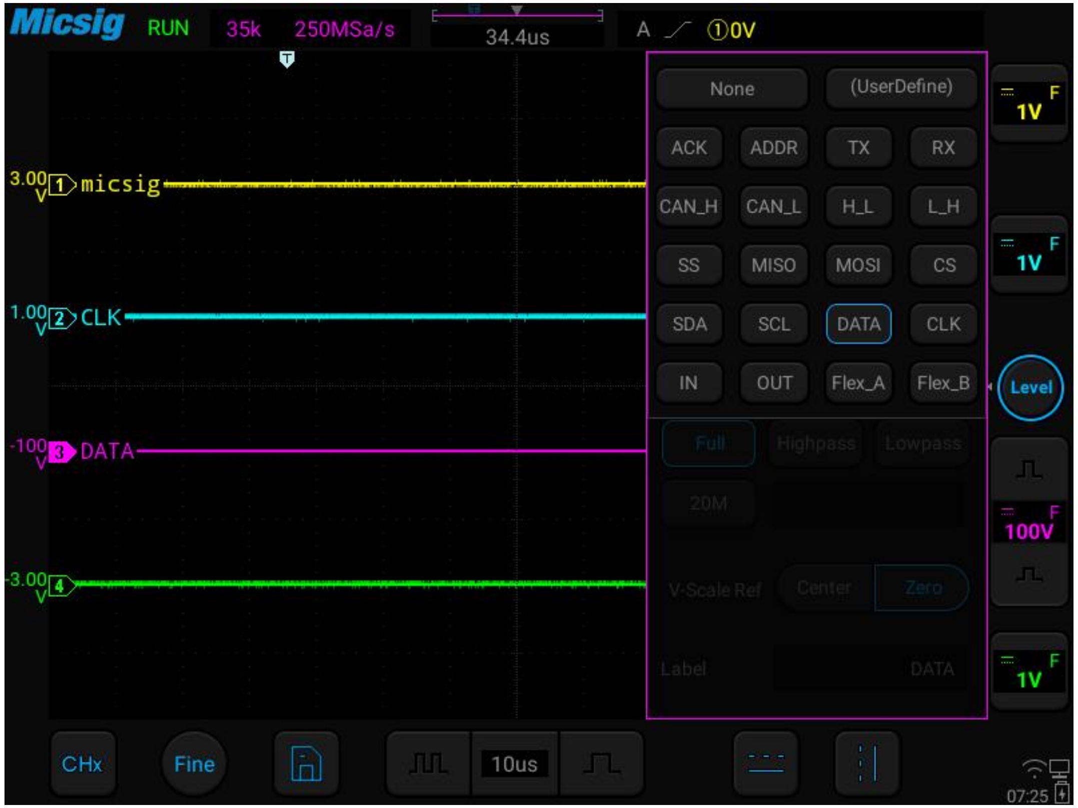


Figure 5-9 Label

Note: Customization supports up to 16 characters.

Chapter 6 Trigger System

This chapter contains the detailed information of the trigger system of the oscilloscope. You are recommended to read this chapter carefully to understand the set functions and operation of the trigger system of the Smart series oscilloscope.

- Trigger and trigger adjustment
- Edge trigger
- Pulse width trigger
- Logic trigger
- Nth edge trigger
- Runt trigger
- Slope trigger
- Time out trigger
- Video trigger
- Serial bus trigger

6.1 Trigger and Trigger Adjustment

What is Trigger?

The oscilloscope can capture a waveform only when it meets a preset condition first. This action of capturing the waveform according to the condition is **Trigger**. The so-called capture waveform is that the oscilloscope grabs a signal and displays it. **If it is not triggered, there is no waveform display**.

What can Trigger be used for?

(1) The oscilloscope can stably display a periodic signal.

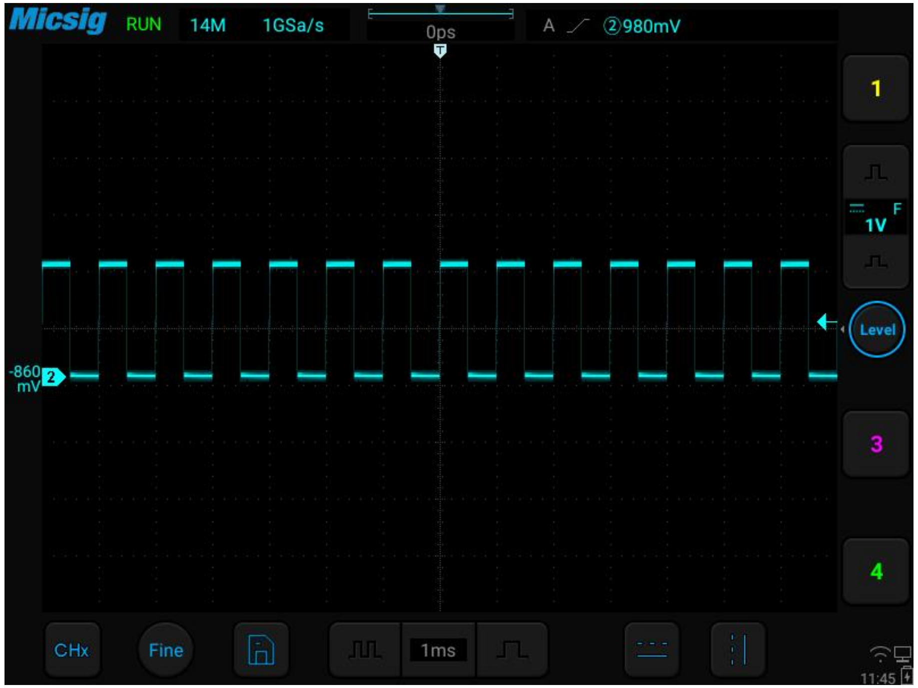


Figure 6-1 Stably Displayed Periodic Signal

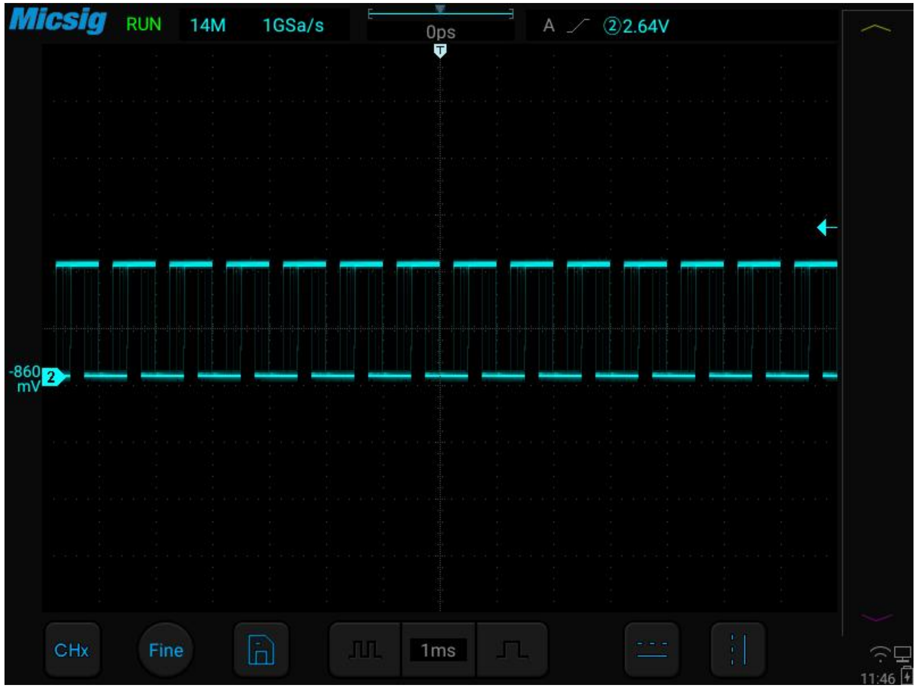


Figure 6-2 Non-Stably Displayed Periodic Signal

(2) Grab the segment you want to observe from a fast and complex signal

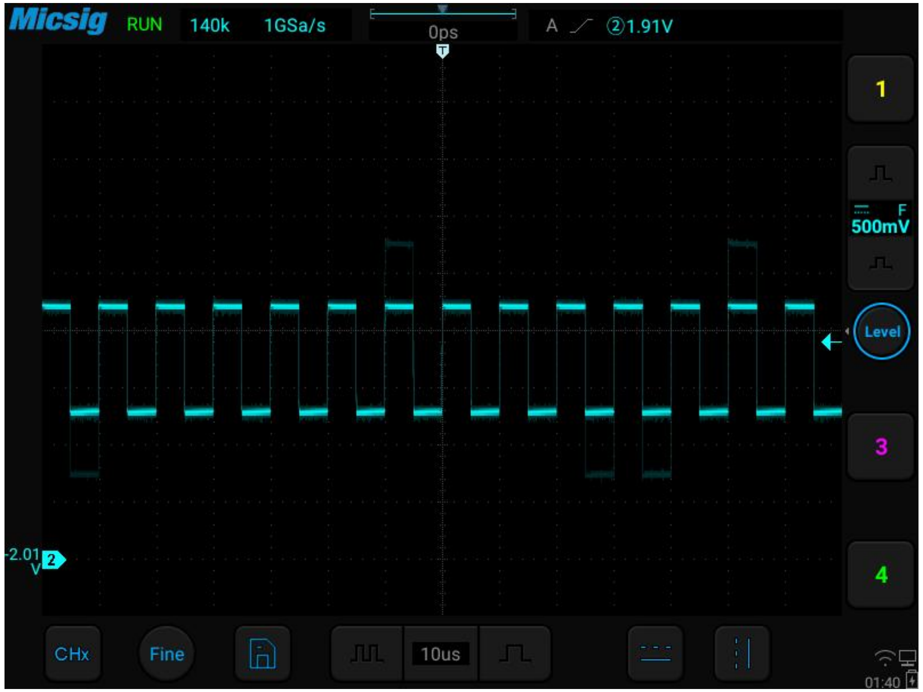


Figure 6-3 Abnormal Signal in Periodic Signals

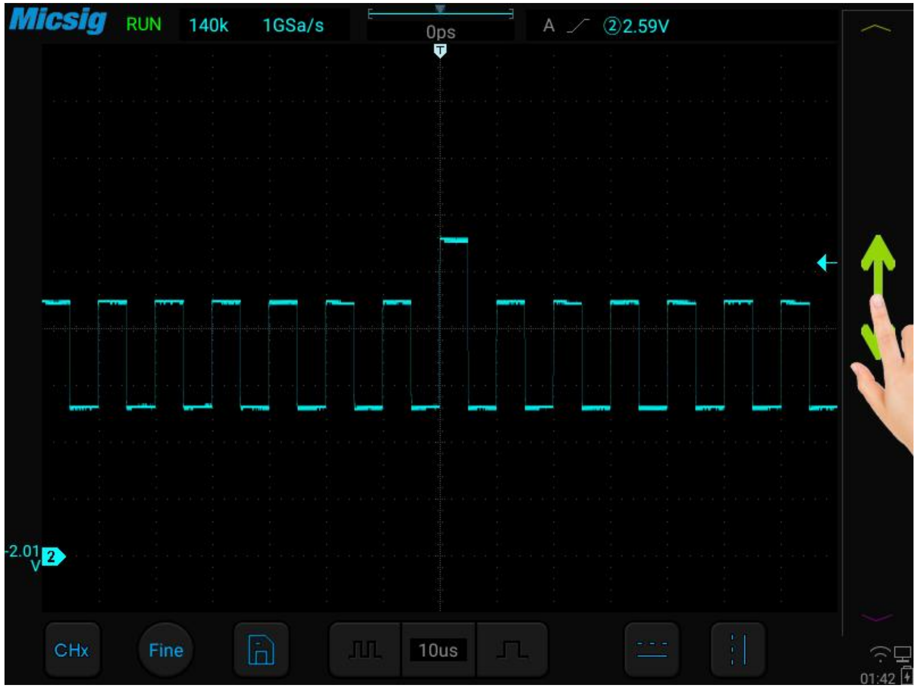


Figure 6-4 Abnormal Signal Captured by Setting Trigger Level

What is Forced Trigger?

When the oscilloscope does not meet the trigger condition, the artificial or automatic oscilloscope trigger is the forced trigger. It means that the oscilloscope only grabs a signal segment for display regardless of whether the condition is met or not.

Automatic forced trigger is set in the menu. In the trigger settings, there is usually a trigger mode option, which can be set as “Normal” or “Auto”. Normal trigger means trigger after meeting the set condition. Automatic trigger is a kind of forced trigger. The oscilloscope will be force triggered if it does not trigger for a certain period of time.



Figure 6-5 Oscilloscope Trigger Mode Setting

If a signal feature is not understood, the oscilloscope should be set as "**Auto**" mode, which can ensure that the oscilloscope can also display the waveform when other trigger settings are not correct. Although the waveform is not necessarily stable, it can provide the intuitive judgment for our further adjustment of the oscilloscope. The signal in Figure 2-9 is the result of forced trigger in "**Auto**" mode.

When we set a specific trigger condition for a specific signal, especially when the time interval for satisfying the trigger condition is long, we need to set the trigger mode to “**Normal**” so as to prevent the oscilloscope from automatic forced trigger.

Figure 6-6 shows a conceptual demonstration of the acquisition memory. In order to understand the trigger event, the acquisition memory can be divided into pre-trigger and post-trigger buffers. The position of the trigger event in the acquisition memory is defined by the time reference point and trigger position (horizontal delay) settings.

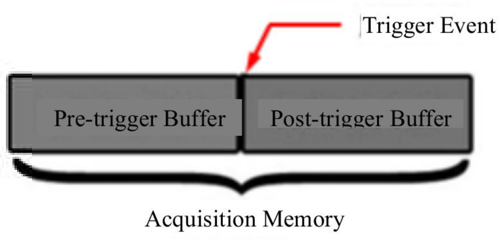


Figure 6-6 Conceptual Demonstration of Acquisition Memory

All events displayed to the left of the trigger point occur before trigger. These events are called pre-trigger messages that show events before the trigger point. All events to the right of the trigger point is called post-trigger

messages. The number of delay ranges available (pre-trigger and post-trigger messages) depends on the selected time base and memory depth.

Adjust trigger position (horizontal delay)

Fingers swipe left and right in the waveform display area, the trigger point will move horizontally, the horizontal delay time changes, and the delay time is displayed at the top center of the screen, that is, the distance between the trigger point and the center line of the waveform display area is displayed.

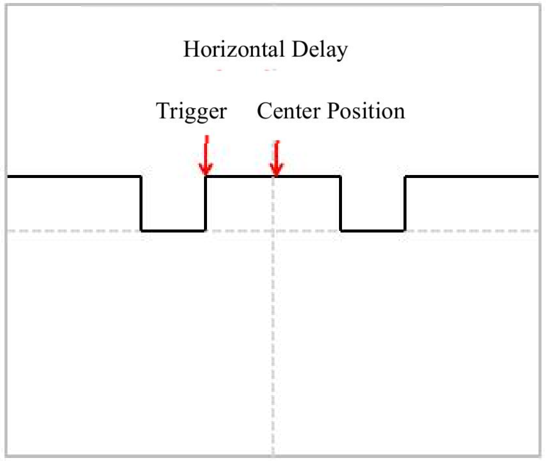


Figure 6-7 Horizontal Delay

When the trigger point is located on the left side to the center line of the waveform display area, the delay time is displayed as a positive value; When the trigger point is located on the right side to the time reference point , and the delay time is displayed as a negative value; the trigger point overlaps with the center line of the waveform display area, and the delay time is zero.

Trigger level

Trigger level is the signal voltage corresponding to the set trigger point. When the trigger level is changed, a horizontal line will appear temporarily on the screen to tell you the level position (the specific value of the trigger level is displayed in the upper right corner of the screen), then the horizontal line disappears, the trigger level is indicated by a small arrow and the indication icon can be dragged to adjust the trigger level value. The trigger level is shown in Figure 6-8 (the arrow indicates the trigger level line).

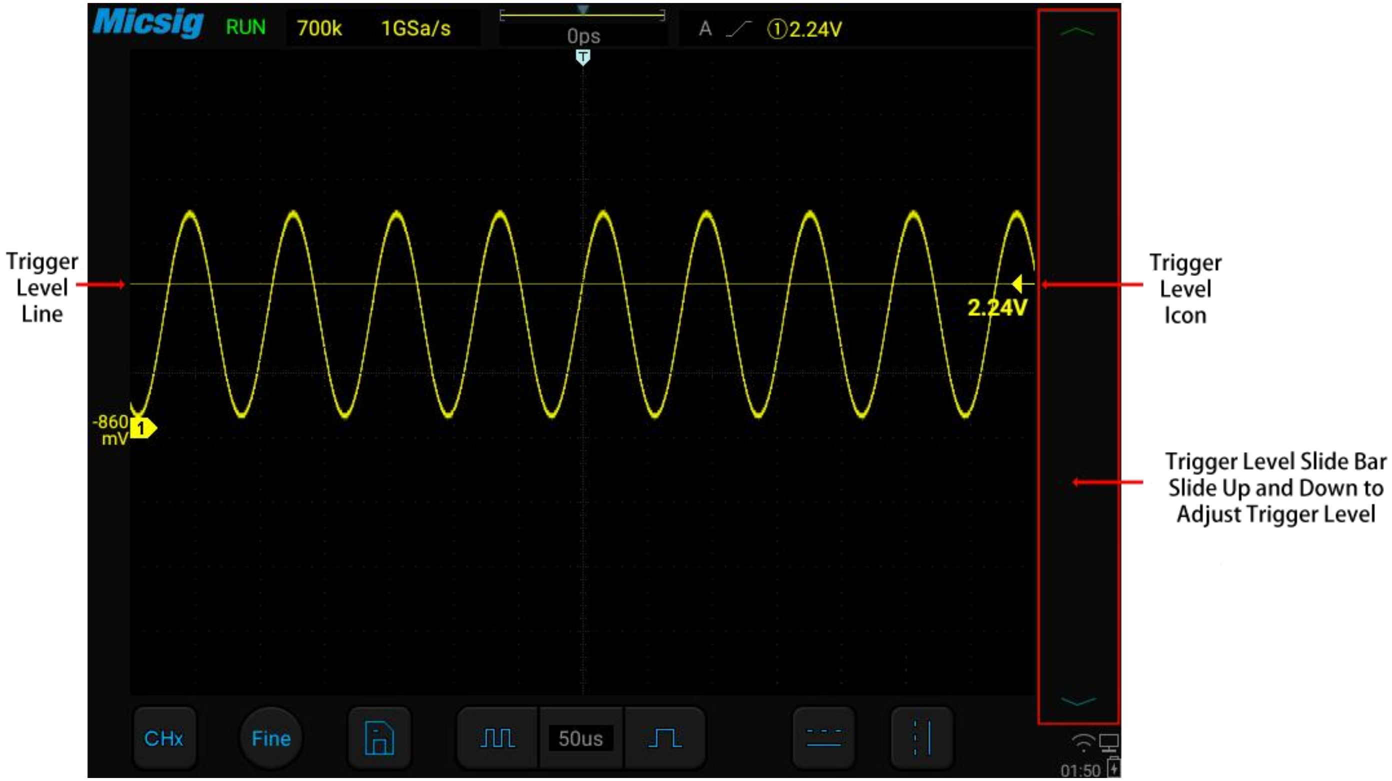


Figure 6-8 Trigger Level

Adjust trigger level

The trigger level can be coarsely adjusted and finely adjusted.

Coarse adjustment: Slide up and down in the trigger level adjustment area.

Fine adjustment: Tap the fine adjustment button in the lower left corner of the screen for fine adjustment of the trigger level.

Trigger setting shortcut

Left swipe from trigger level slide bar to open trigger setting shortcut, which includes trigger source, trigger mode etc.

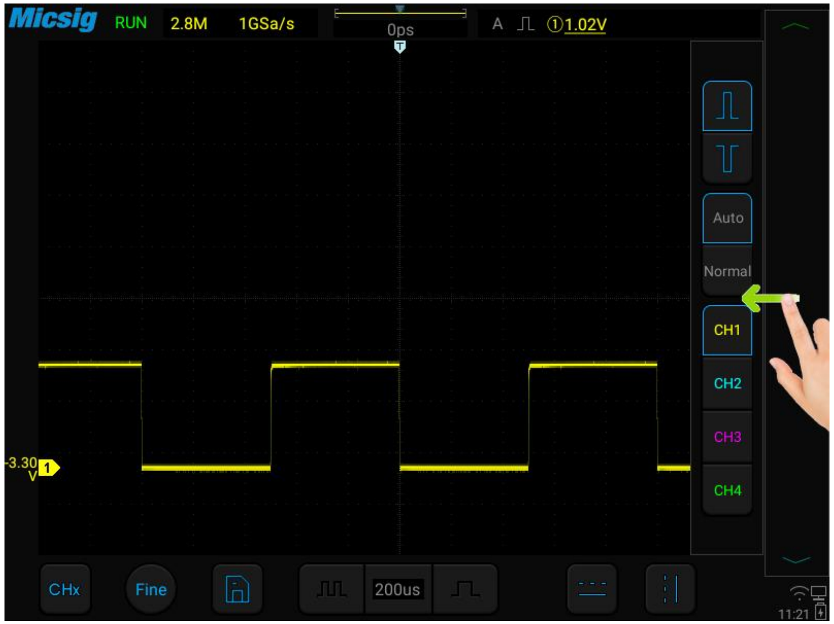


Figure 6-9 Trigger setting shortcut

Set trigger hold-off time

The trigger hold-off time can set up the waiting time of the oscilloscope after the trigger and before the trigger circuit is reconnected. During hold-off time, the oscilloscope does not re-trigger until the end of the hold-off time, and the hold-off time can be used to stably trigger complex waveforms. The trigger hold-off time ranges from 200ns~10s.

The hold-off may be used to trigger on repetitive waveforms with multiple edges (or other events) between waveform repetitions. If the shortest time between triggers is known, the hold-off may also be used to trigger on the first edge.

For example, to obtain stable trigger on the repetitive pulse trigger shown below, set the hold-off time to a value >200ns but <600ns.

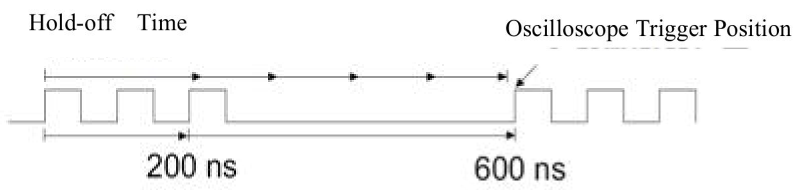


Figure 6-10 Trigger Hold-Off Time

Set trigger hold-off time:

1) Tap “Trigger” on the main menu to open the trigger menu. Under “Common”, tap the box after “Rejection Time” to open the hold-off time adjustment interface. The trigger time is displayed on the upper left, the fine adjustment time scale is displayed on the upper right, and the coarse time scale is displayed below, as shown in Figure 6-11.

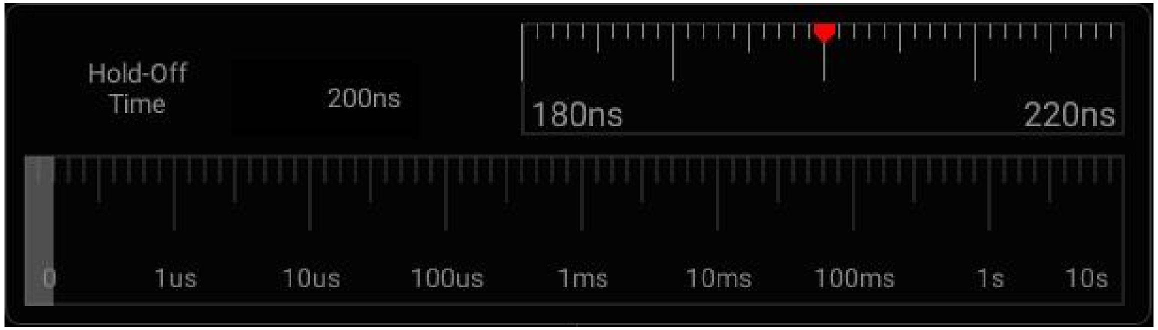


Figure 6-11 Trigger Hold-Off Time Set Interface

2) When adjusting the time, drag or tap the coarse adjustment scale for coarse adjustment, and then drag the fine adjustment scale for fine adjustment of the hold-off time.

Trigger hold-off operation prompt

It is typically used for complex waveforms. The correct rejection setting is usually slightly smaller than one repetition of the waveform. Setting the hold-off time to this time can become the only trigger point for the repetitive waveform.

Changing the time base setting will not affect the trigger hold-off time.

Using Zoom function, you can tap “Run/Stop” to stop, then horizontally move and zoom the data to find the position where the waveform is repeated. Use the cursor to measure this time and then set the hold-off time.

- Use “SingleSEQ” button for single acquisition

Usually when performing a single acquisition, you must initiate some operations on the measured equipment, and the oscilloscope is not desired to trigger automatically before these operations. The trigger condition indicator WAIT is displayed in the upper left corner of the screen before starting operations in the circuit (this means the pre-trigger buffer is filled).

6.2 Edge Trigger

When the edge of trigger signal reaches a certain trigger level, the set signal is triggered and generated. Trigger occurs on either edge of the rising edge (indicating icon at the top of the screen), falling edge () or dual edge (), and the trigger level can be set to change the vertical position of the trigger point on the trigger edge, namely the intersection point of the trigger level line and the signal edge. The stable waveform can be obtained by correctly setting the edge trigger coupling mode. Edge trigger menu is shown in the table below:

Trigger Option	Setting	Description
Trigger Source	CH1	Set CH1 as trigger signal source
	CH2	Set CH2 as trigger signal source
	CH3	Set CH3 as trigger signal source
	CH4	Set CH4 as trigger signal source
Slope	Rising edge	Set signal trigger on the rising edge

	Falling edge	Set signal trigger on the falling edge
	Dual edge	Set signal trigger on either rising edge or falling edge
Coupling	DC	AC and DC components getting through trigger signals
	AC	Filter out the DC component of trigger signals
	HF rejection	Suppress signals above 50KHz in trigger signals
	LF rejection	Suppresses signals below 50KHz in trigger signals
	Noise rejection	Low-sensitivity DC coupling to suppress high-frequency noise in trigger signals

Set CH1 rising edge trigger and coupling as DC with operation steps as follows:

1) Tap "Trigger" on the main menu to open the trigger menu, select edge trigger in the trigger type, and set edge trigger as follows, as shown in Figure 6-11:

- Trigger source: CH1;

- Trigger coupling mode: DC;
- Trigger edge: rising.



Figure 6-12 Edge Trigger Setting Menu

2) Adjust the trigger level to ensure that the waveform can be triggered stably, for example, the trigger level is set to 1V.

Trigger coupling description

When the edge trigger setup menu is opened, the trigger coupling option is displayed below the menu. Trigger coupling includes DC, AC, HFRei., LFRej., NoiseRej, see Figure 6-13:



Figure 6-13 Trigger Coupling Menu

1) DC coupling - allows DC and AC signals to enter the trigger path.

2) AC coupling - removes any DC offset voltage from the trigger waveform.

   When the waveform has a large DC offset, stable edge triggering can be achieved using AC coupling.

3) HFRej. (High Frequency Rejection Coupling) - removes high frequency components from the trigger waveform, using high frequency rejection to remove high frequency noises or noises from fast system clocks, from trigger paths such as AM or FM radio stations.

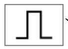
4) LFRej. (Low Frequency Rejection Coupling) - removes any unnecessary low frequency components from the trigger waveform, for example, power line frequencies that can interfere with correct trigger.

When there is low frequency noise in the waveform, stable edge triggering can be obtained using LF rejection coupling.

5) NoiseRej. (Noise Rejection Coupling) - Noise rejection can add extra hysteresis to the trigger circuit. By increasing the trigger hysteresis band, the possibility of noise triggering can be reduced. But it also reduces the trigger sensitivity, so triggering the oscilloscope requires a slightly larger signal.

Note: Trigger coupling is independent of channel coupling.

6.3 Pulse Width Trigger

The trigger happens when the trigger signal pulse width (8ns~10s, the trigger type indication icon at the top of the screen is ) reaches the set condition and the signal voltage reaches the set trigger level. Pulse width trigger menu is shown in the following table:

Trigger Option	Setting	Description
Trigger Source	CH1	Set CH1 as trigger signal source
	CH2	Set CH2 as trigger signal source

Trigger Option	Setting	Description
	CH3	Set CH3 as trigger signal source
	CH4	Set CH4 as trigger signal source
Polarity	Positive	Trigger on setting the positive pulse width of signals
	Negative	Trigger on setting the negative pulse width of signals
Trigger Condition	< T	Trigger when the signal pulse width is smaller than pulse width T
	> T	Trigger when the signal pulse width is greater than pulse width T
	= T	Trigger when the signal pulse width is equal to pulse width T
	≠T	Trigger when the signal pulse width is not equal to pulse width T
Trigger Pulse Width	8ns~10s	Set the trigger pulse width

Notes: Conditions of greater than, smaller than, equal to or not equal to indicating that the error is 6%.

Trigger steps of positive polarity pulse width: (taking CH1 as an example)

1) Tap “Trigger” on the main menu to open the trigger menu, select the pulse width trigger in the trigger type, and set the pulse width trigger as follows, as shown in Figure 6-14:

- Trigger source: CH1;
- Trigger pulse polarity: positive;
- Trigger level: 1V
- Trigger condition and pulse width time: “greater than”, the adjustment time is 180us.

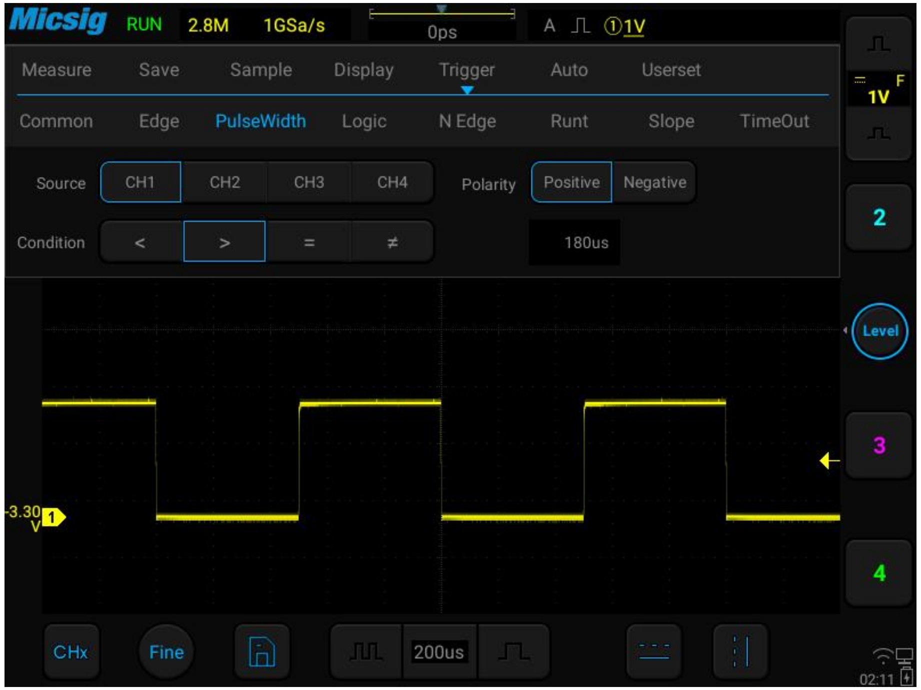


Figure 6-14 Pulse Width Trigger Setting Menu

Pulse width trigger setting description:

1) Pulse polarity selection

The selected pulse polarity icon is displayed in the upper right corner of the display screen. The positive pulse is higher than current trigger level (CH1 positive pulse indication icon ⎍ ① 1.00V), and the negative pulse is

lower than current trigger level (CH1 negative pulse indication icon ① 1.00V). When triggered on positive polarity pulse, if the restrictions are true, the trigger will happen on the high-to-low transition of the pulse; when triggered on negative polarity pulse, if the restrictions are true, the trigger will happen on the low-to-high transition. (Figure 6-15 Negative Pulse Level Flip)

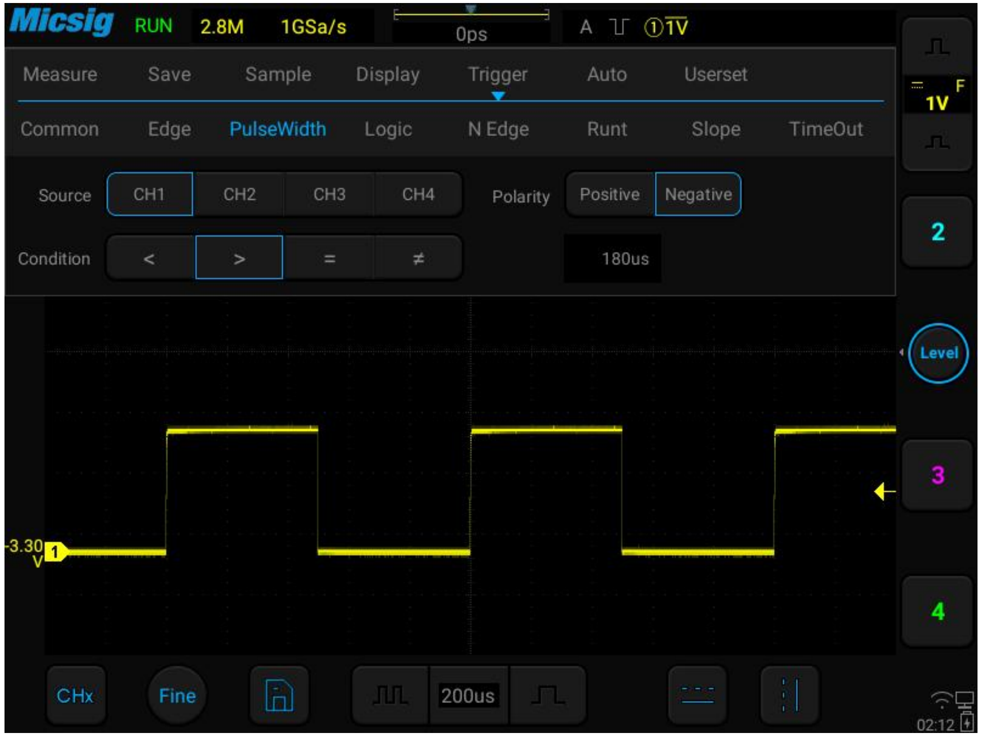


Figure 6-15 Negative Polarity Pulse Level Flip

2) Trigger condition and pulse width time setting

Time restrictions that can set in the trigger condition: <, >, =, ≠.

- Smaller than the time value (<)

  For example, for positive pulse, if it is set as T<80ns, the trigger will happen stably only when the pulse width is smaller than 80ns (Figure 6-16 Trigger Time T<80ns).

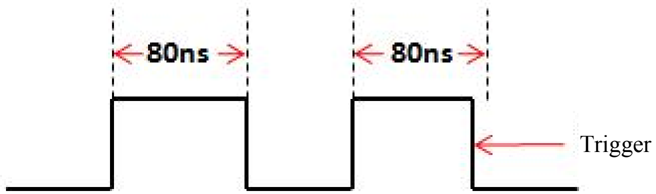


Figure 6-16 Trigger Time T<80ns

- Greater than the time value (>)

  For example, for positive pulse, if it is set as T>80ns, the trigger will happen stably only when the pulse width is greater than 80ns (Figure 6-17 Trigger Time T>80ns).

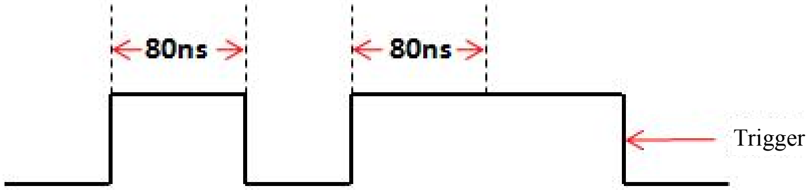


Figure 6-17 Trigger Time T>80ns

- Equal to the time value (=)

For example, for positive pulse, if it is set as T=80ns, the trigger will happen stably only when the pulse width is equal to 80ns (Figure 6-18 Trigger Time T=80ns).

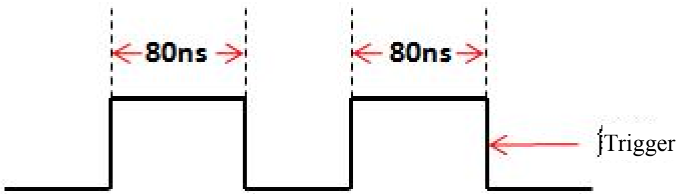


Figure 6-18 Trigger Time T=80ns

- Not equal to the time value (≠)

For example, for positive pulse, if it is set as T≠80ns, the trigger will happen stably only when the pulse width is not equal to 80ns (Figure 6-19 Trigger Time T≠80ns).

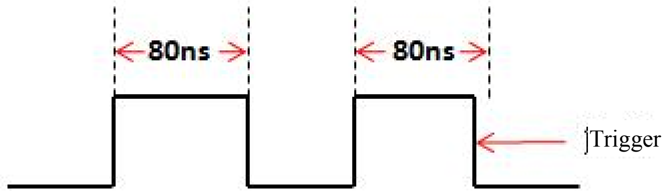
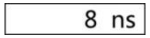


Figure 6-19 Trigger Time T≠80ns

The trigger pulse width time can be set as 8ns~10s.

Tap the pulse width time setting box  to pop up the time adjustment interface (as shown in Figure 6-20), and adjust the pulse width time. Adjust the pulse width time by adjusting or dragging the time scale.

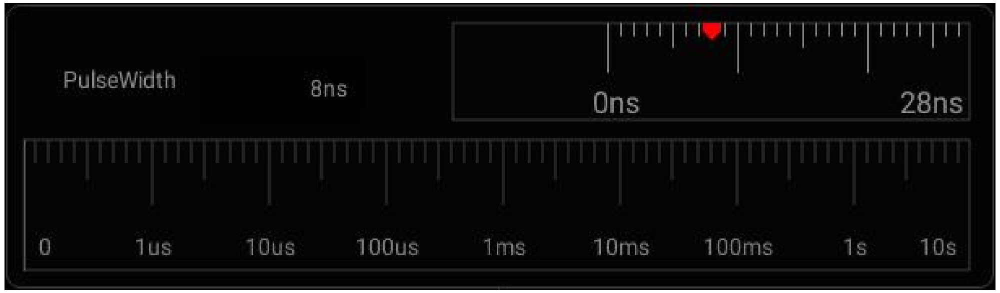


Figure 6-20 Pulse Width Time Adjustment Interface

6.4 Logic Trigger

Trigger happens when the level between analog channels satisfies a certain logical operation (AND, OR, NAND, NOR) and the signal voltage reaches the set trigger level and the trigger logic width (8ns~10s). Logic trigger menu descriptions are shown in the table below:

Trigger Option	**Setting**		**Description**
Trigger Source	CH1	High	Set CH1 as high
		Low	Set CH1 as low
		None	Set CH1 as none
	CH2	High	Set CH2 as high
		Low	Set CH2 as low
		None	Set CH2 as none

	CH3	High	Set CH3 as high
		Low	Set CH3 as low
		None	Set CH3 as none
	CH4	High	Set CH4 as high
		Low	Set CH4 as low
		None	Set CH4 as none
Trigger Logic	AND		Select the logic of trigger source as “AND”
	OR		Select the logic of trigger source as “OR”
	NAND		Select the logic of trigger source as “NAND”
	NOR		Select the logic of trigger source as “NOR”
Trigger Condition	Change to true value		Trigger when the logic changes to true value
	Change to false value		Trigger when the logic changes to false value
	<, >, =, ≠T		If logic status for hold time as <, >, =, ≠T, then trigger

Logic Time	8ns~10ns	Set trigger logic time

Notes: Conditions of greater than, smaller than, equal to or not equal to indicating that the error is 6%.

Logic trigger operation steps between channels:

1) Tap "Trigger" on the main menu to open the trigger menu, select logic trigger in the trigger type, and set the logic trigger as follows, as shown in Figure 6-21:

- Logic levels: CH1, CH3: High; CH2, CH4: Low; (without reference to the channel of logic operation, the level selection is None to avoid interference to the logic operation);
- Logic gate: AND;
- Condition: <;
- Logic time: 400ns.

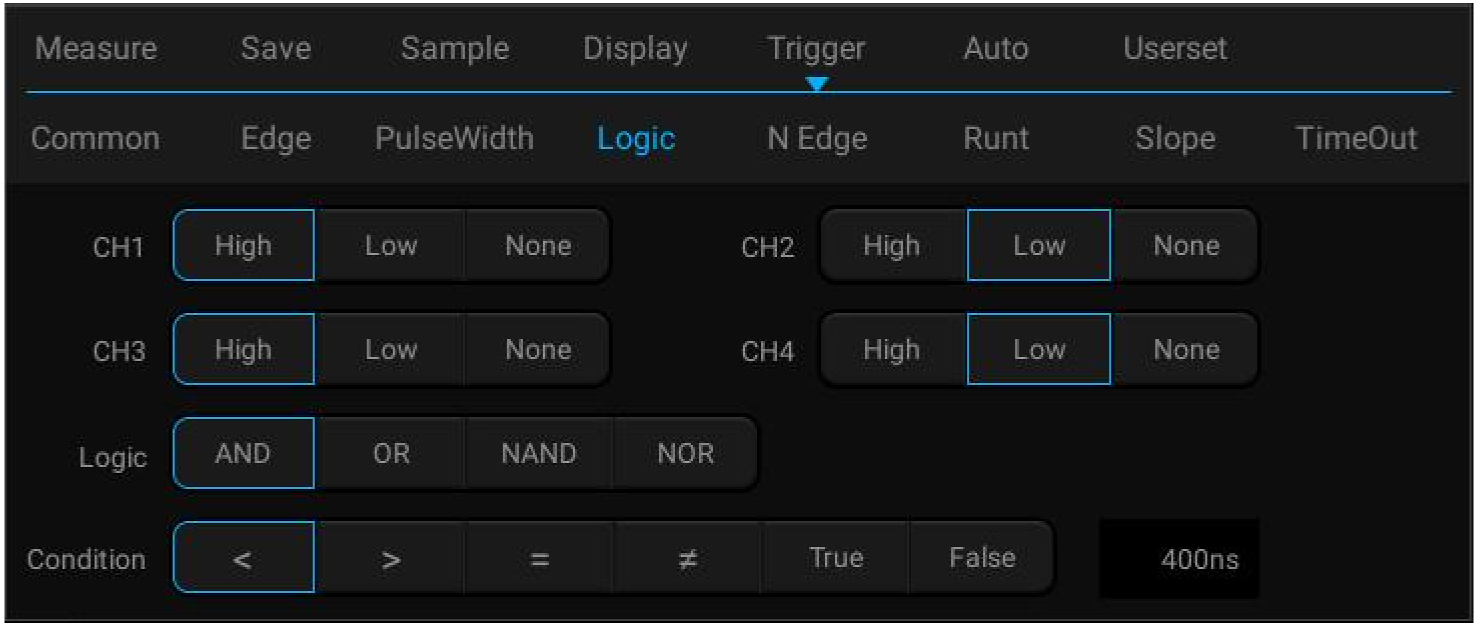


Figure 6-21 Logic Trigger Setting Menu

Logic trigger setting description:

Logic level setting

After trigger source, select High, Low and None for the channel. The corresponding trigger level value is displayed in the upper right corner of the display screen.

High: means a value higher than the current trigger level, and the icon indication is "0.0V".

Low: means a value lower than the current trigger level, and the icon indication is “0.0V”.

None: This channel is invalid.

Switch the trigger level channel: Tap the trigger level slide bar arrow or use trigger setting shortcut

Logic conditions

1) True: Trigger when the logic changes to true value

2) False: Trigger when the logic changes to false value

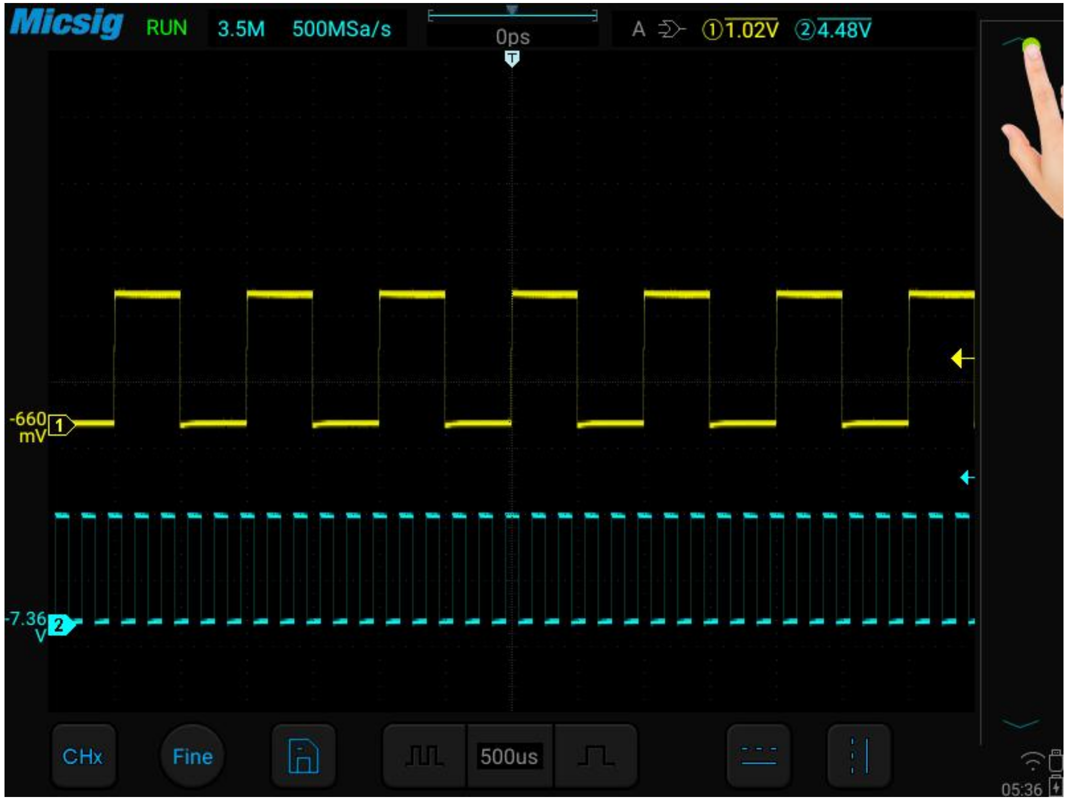


Figure 6-22 Trigger Level Adjustment

Trigger pulse width time can be set as 8ns~10s.

Tap the time setting box (400ns) to pop up the time adjustment interface and adjust the logic time. Please refer to the Pulse Width Adjustment section for details.

6.5 Nth Edge Trigger

When the trigger signal is triggered on the Nth edge after the specified idle time, it is Nth edge trigger. Menu descriptions of the Nth edge trigger are shown in the table below:

Trigger Option	Setting	Description
Trigger Source	CH1	Set CH1 as trigger signal source
	CH2	Set CH2 as trigger signal source
	CH3	Set CH3 as trigger signal source
	CH4	Set CH4 as trigger signal source
Time	8ns~10s	Idle time
Edge	Rising edge	Set signal trigger on the rising edge
	Falling edge	Set signal trigger on the falling edge
Nth Edge	1~65535	Set trigger on Nth edge after idle time

Set CH1 to trigger on the 5th rising edge after 500us. The steps are as follows:

1) Tap "Trigger" on the main menu to open the trigger menu, select Nth edge trigger in the trigger type, and set the Nth edge trigger as follows, as shown in Figure 6-23:

- Trigger source: CH1;
- Time: 10ms;
- Edge signal: rising;
- Nth edge: 99

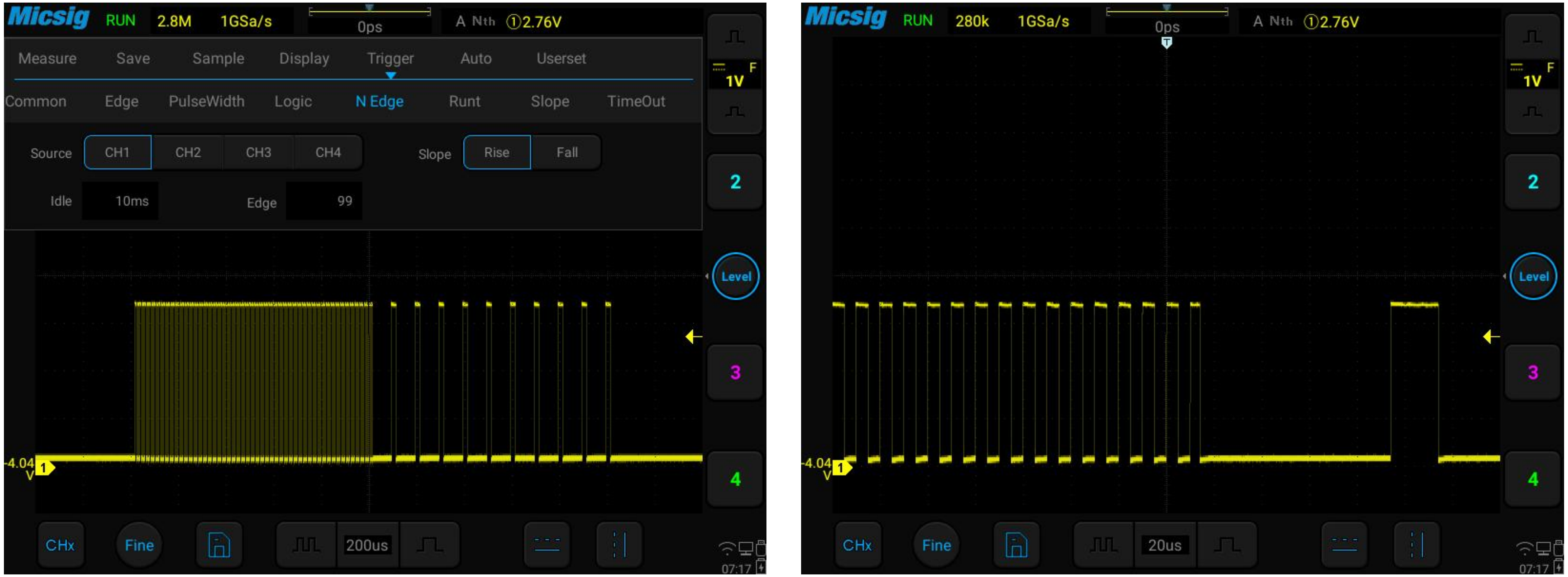


Figure 6-23 Nth Edge Trigger Menu

2) Adjust the trigger level to ensure that the waveform can be triggered stably, for example the trigger level is set to 1.44V.

6.6 Runt Trigger

By setting the high and low thresholds, trigger on a pulse that cross one threshold but fail to cross a second threshold. There are two types available: positive short pulse and negative short pulse.

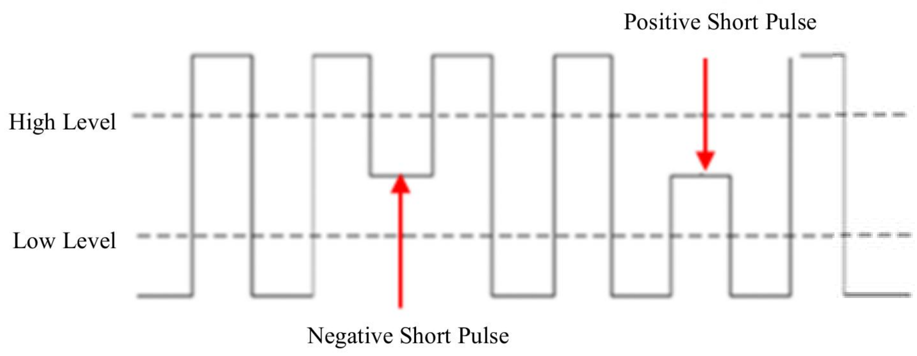


Figure 6-24 Runt Trigger

Runt trigger menu descriptions are shown in the table below:

Trigger Option	Setting	Description
Trigger Source	CH1	Set CH1 as trigger signal source

Trigger Option	Setting	Description
	CH2	Set CH2 as trigger signal source
	CH3	Set CH3 as trigger signal source
	CH4	Set CH4 as trigger signal source
Polarity	Positive	Set signal to trigger on positive runt pulse
	Negative	Set signal to trigger on negative runt pulse
	Any	Set signal to trigger on either positive or negative runt pulse
Trigger Condition	<T	Trigger when the signal pulse width is smaller than pulse width T
	>T	Trigger when the signal pulse width is greater than pulse width T
	<>T	Trigger when the signal pulse width is greater than lower limit T1 and smaller than upper limit T2
	None	No trigger restrictions for runt pulse trigger
Trigger Pulse	8ns~10s	Set the trigger pulse width

Trigger Option	Setting	Description
Width		

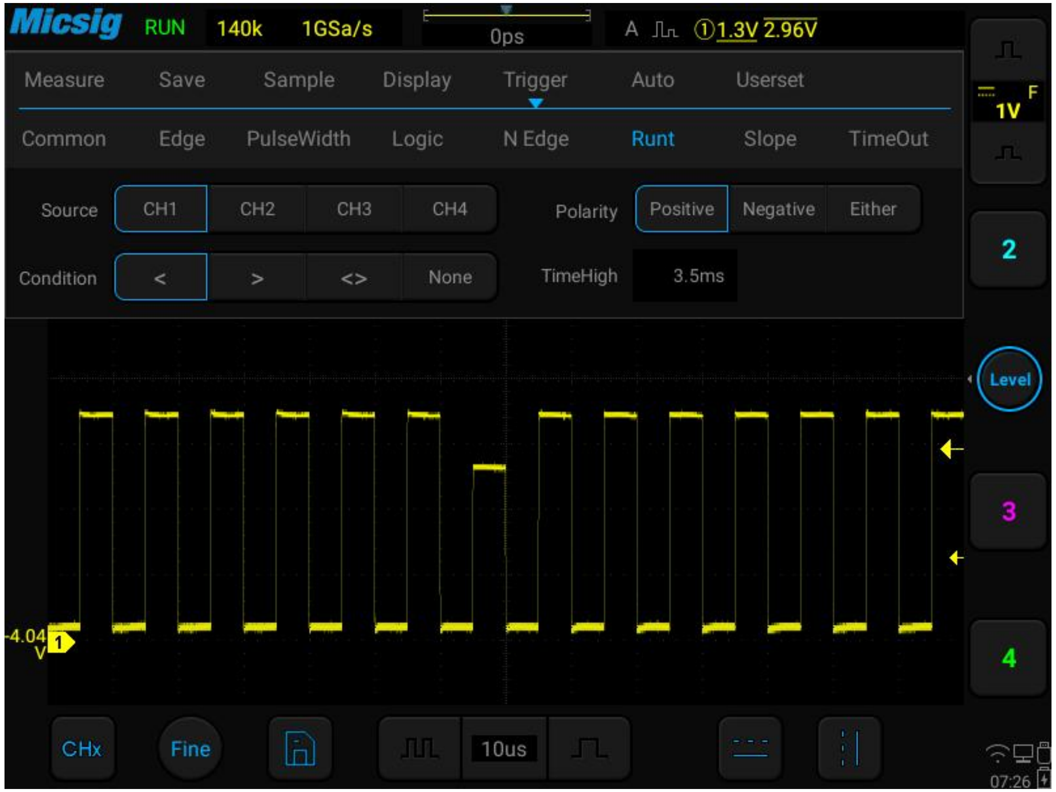


Figure 6-25 Runt Trigger Setting Menu

6.7 Slope Trigger

Slope Trigger means trigger when the waveform reaches a set time condition from one level to another.

Positive slope time: Time takes for the waveform to go from low to high.

Negative slope time: Time takes for the waveform to go from high to low.

As shown in Figure 6-26

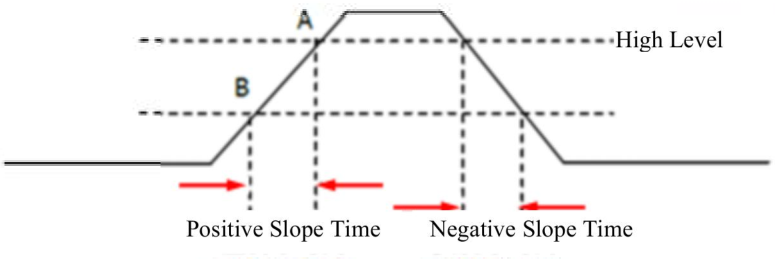


Figure 6-26 Positive/Negative Slope Time

When the trigger signal slope has the hold time (8ns~10s), the trigger type on the top of the screen is only the icon , and trigger happens when the set condition is reached. Slope trigger is suitable for observing sawtooth or triangular waves. The slope trigger menu descriptions are shown in the table below:

Trigger Option	Setting	Description
Trigger Source	CH1	Set CH1 as trigger signal source
	CH2	Set CH2 as trigger signal source
	CH3	Set CH3 as trigger signal source
	CH4	Set CH4 as trigger signal source
Edge	Rising	Set trigger on positive signal slope
	Falling	Set trigger on negative signal slope
	Any	Set trigger on detecting a signal slope change
Trigger Condition	<T	Trigger when the signal slope hold time is smaller than T
	>T	Trigger when the signal slope hold time is greater than T
	<>T	Trigger when the signal slope hold time is smaller than upper limit T1 and greater than lower limit T2
Time	8ns~10s	Set the trigger signal slope hold time

Set CH1 slope status as rise and hold time less than 1ms. The steps are as follows:

1) Tap "Trigger" on the main menu to open the trigger menu, select the slope trigger in the trigger type, and set the slope trigger as follows, as shown in Figure 6-27:

- Trigger source: CH1;
- Edge: Rise;
- Slope hold time: 1us;

2) Adjust trigger level, adjust High or Low trigger level, click arrow at both ends of the chute Switch the trigger level between High and Low.

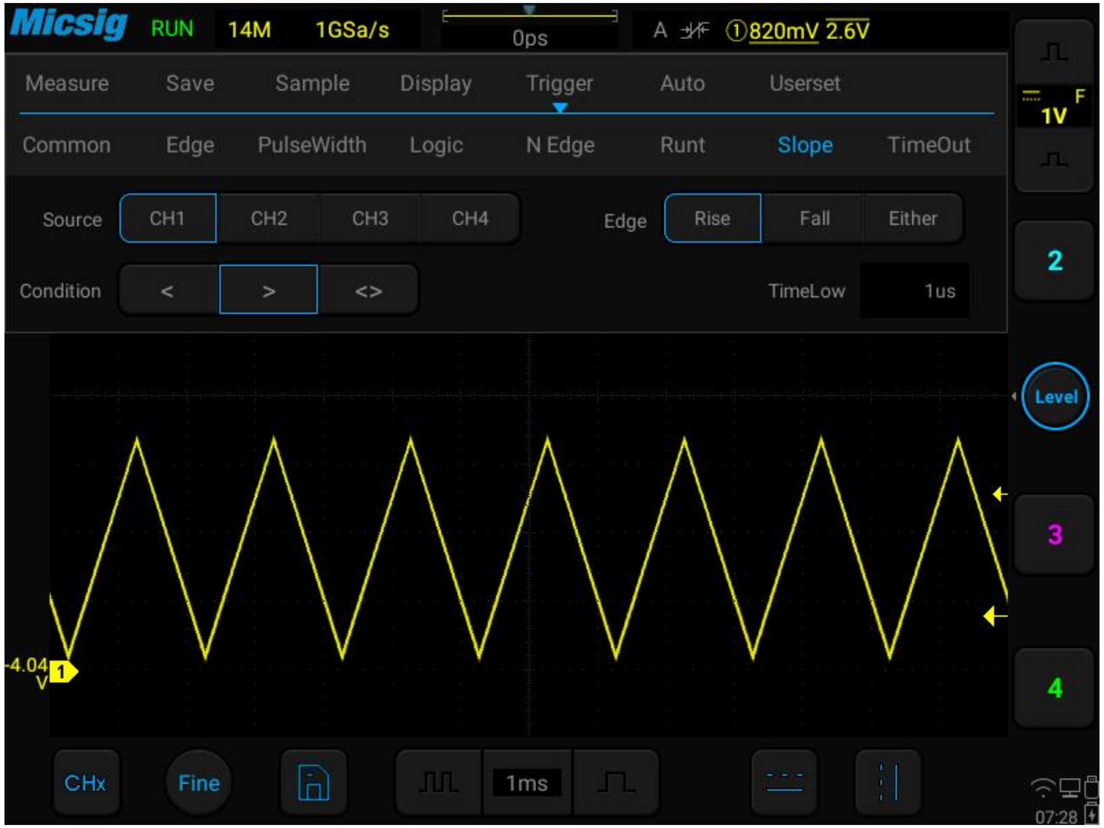


Figure 6-27 Slope Trigger Setting Menu

The slope hold time can be set as 8ns~10s.

Note: A stable trigger waveform can only be obtained by selecting the channel to which signals are connected as trigger source.

6.8 Timeout Trigger

Timeout trigger happens when the time from the intersection of signal and trigger level and above (or below) the trigger level reaches the set time, as shown in Figure 6-28:

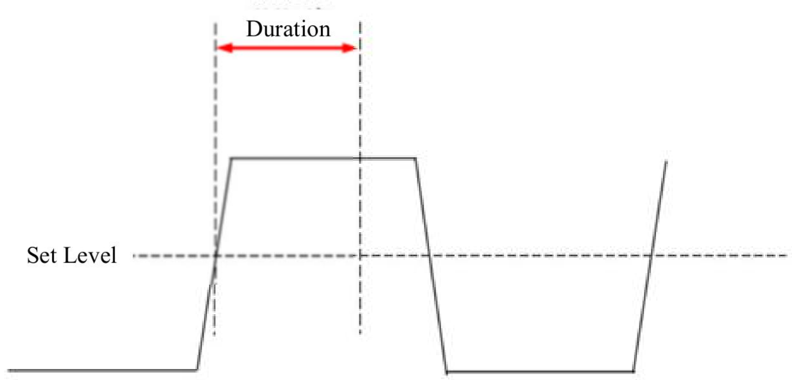


Figure 6-28 Timeout Trigger Schematics

Timeout trigger menu descriptions are shown in the table below:

Trigger Option	**Setting**	**Description**
Trigger	CH1	Set CH1 as trigger signal source

Source	CH2	Set CH2 as trigger signal source
	CH3	Set CH3 as trigger signal source
	CH4	Set CH4 as trigger signal source
Polarity	Positive	Select to count time when the rising edge of input signal gets through the trigger level
	Negative	Select to count time when the falling edge of input signal gets through the trigger level
	Any	Select to count time when the rising edge or falling edge of input signal gets through the trigger level
Time	8ns~10s	Timeout time

Set the polarity of CH1 trigger signal to be positive and the timeout time as 15us. The steps are as follows:

1) Tap "Trigger" on the main menu to open the trigger menu, select timeout trigger in the trigger type, and set the timeout trigger as follows, as shown in Figure 6-29:

- Trigger source: CH1;
- Edge: positive;
- Timeout time: 8ns;

2) Adjust the trigger level to ensure that the waveform can be triggered stably.

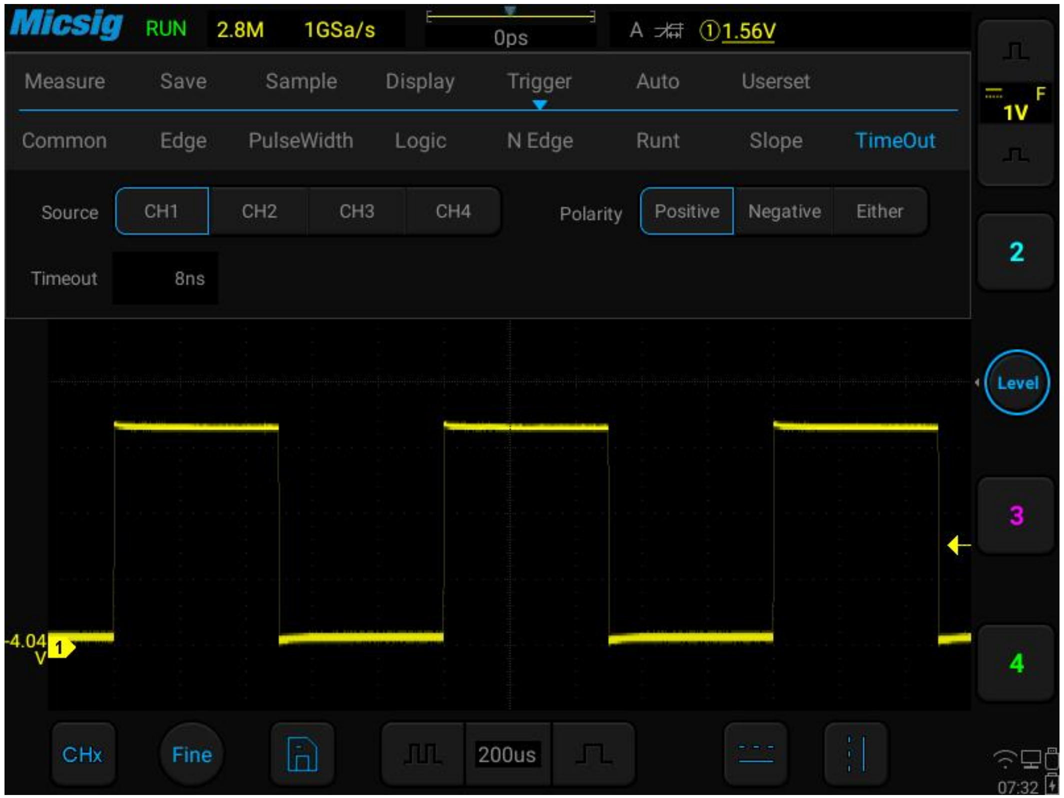


Figure 6-29 Time-out Trigger

6.9 Video Trigger

The triggering method for video signals depends on video formats. Generally, there are PAL/625, SECAM, NTSC/525, 720P, 1080I and 1080P formats. The video trigger can be triggered at different voltage scales, and the appropriate voltage scale can be adjusted as needed to observe the waveform. The video trigger menu descriptions are shown in the table below:

Trigger Option	**Setting**	**Description**
Trigger Source	CH1	Set CH1 as trigger signal source
	CH2	Set CH2 as trigger signal source
	CH3	Set CH3 as trigger signal source
	CH4	Set CH4 as trigger signal source

Trigger Option	**Setting**	**Description**
Polarity	Positive	Set signal positive polarity trigger
	Negative	Set signal negative polarity trigger
Video Standard	625/PAL	Based on PAL signal trigger
	SECAM	Based on SECAM signal trigger
	525/NTSC	Based on NTSC signal trigger
	720P	Base on 720P(50Hz, 60Hz) signal trigger
	1080I	Base on 1080I(50Hz, 60Hz) signal trigger
	1080P	Base on 1080P (24Hz, 25Hz, 30Hz, 50Hz, 60Hz) signal trigger
Line		Trigger lines
	Odd fields	Trigger on the rising edge of the first tooth pulse in odd

Trigger Option	**Setting**		**Description**
Trigger			fields
	Even fields		Trigger on the rising edge of the first tooth pulse in even fields
	All fields		Trigger on the rising edge of the first tooth pulse found
	All lines		Trigger on all horizontal sync pulses
Trigger	Line	625 line (PAL,SECAM)	Trigger on a specified line in odd or even fields
		263 odd line 262 even line (NTSC)	
		750 line (720P)	
		1125 line (1080I,1080P)	

Set CH1 as trigger channel, positive polarity, NTSC standard video, all fields trigger, and the steps are as follows:

1) Tap “Trigger” on the main menu to open the trigger menu, select the video trigger in the trigger type, and set the video trigger as follows, as shown in Figure 6-30:

- Trigger source: CH1;
- Polarity: positive;
- Standard: 525/NTSC;
- Trigger: Odd fields

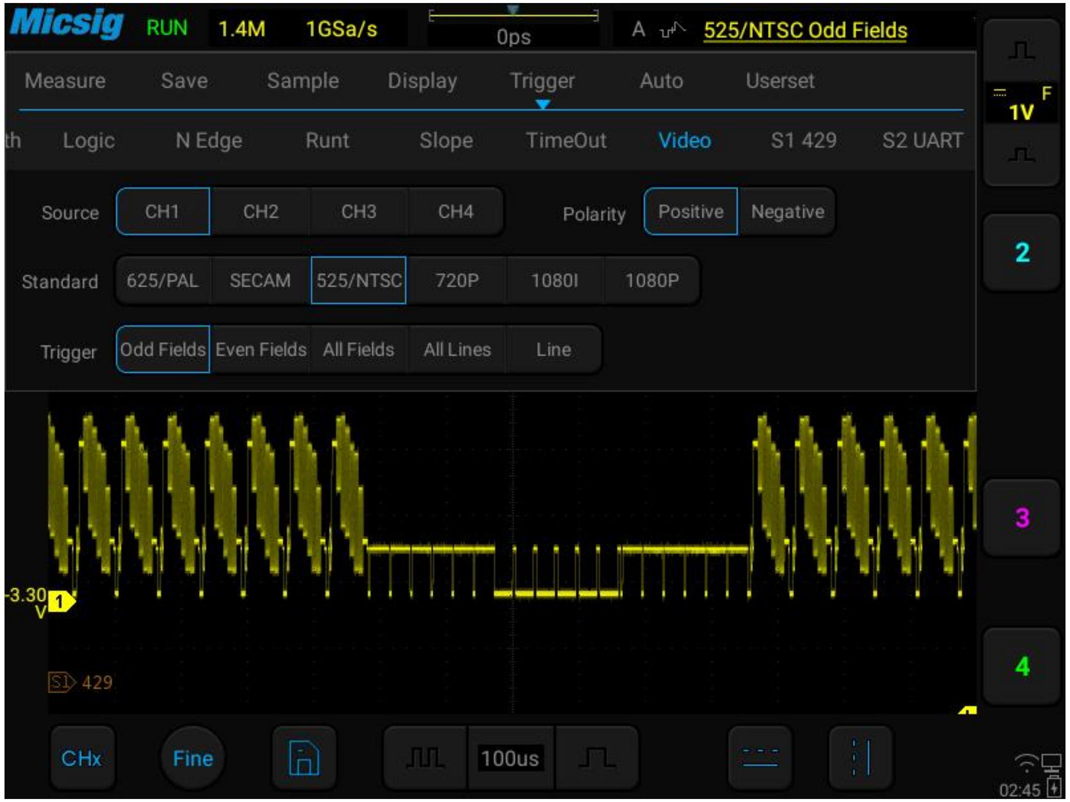


Figure 6-30 Video Trigger

Prompts:

- In order to better observe the waveform details in the video signal, first set the memory depth to be larger.

- During the trigger debugging of the video signal, since the digital oscilloscope has multi-level gray scale display function, different brightness can reflect the frequency of different parts of the signal. Experienced users can quickly judge the quality of the signal during the debugging process and find abnormal conditions.

6.10 Serial Bus Trigger

Please refer to Chapter 12 Serial Bus Trigger and Decode (Optional)

Chapter 7 Analysis System

This chapter contains the detailed information of the analysis system of the oscilloscope. You are recommended to read this chapter carefully to understand the set functions and operation of the analysis system of the Smart series oscilloscope.

- Automatic measurement
- Frequency meter measurement
- Cursor

7.1 Automatic Measurement

Measurement setting

Slide down from top, open the main menu, tap “Measure” to enter the measurement menu. There are 23 measurement items on the measurement menu. Measurement menu, selected measurement item display and measurement item display are shown in Figure 7-1:

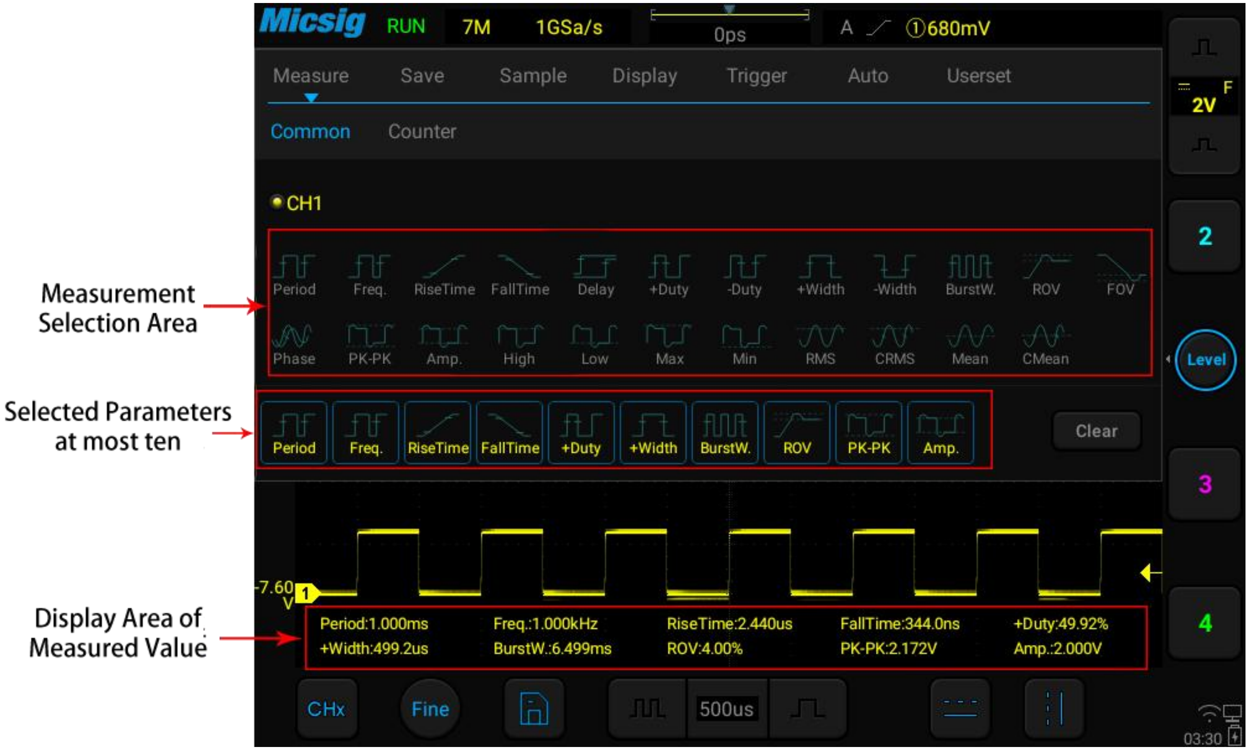


Figure 7-1 Automatic Measurement Menu

Automatic measurement

1) Select channel: Select the channel to be measured above the measurement menu.

2) Select measurement: Select the desired measurement item on the measurement menu. The selected measurement item is displayed in the “Selected Parameters” display area below.

3) Press top Menu button on the key area to quickly close the measurement menu.

4) Cancel measurement item: In the “Selected Parameters” display area below measurement menu, tap the measurement item to be cleared; or tap Clear button to clear all measurement items.

Note:

Measurements and math functions will be recalculated when moving/zooming and opening/closing channels.

Oscilloscope has an automatic measurement memory function. Shutdown and restart will not automatically clear added automatic measurement options.

All measurements

Slide from bottom, open the **pull-up menu**, see Figure 7-2, click Clear to open all measurement items, display the current channel measurement value. Switch the current channel to open all the measurement items of other channels, as shown in Figure 7-3; click again to turn off all measurements.



Figure 7-2 Pull-up Menu



Figure 7-3 All Measurements

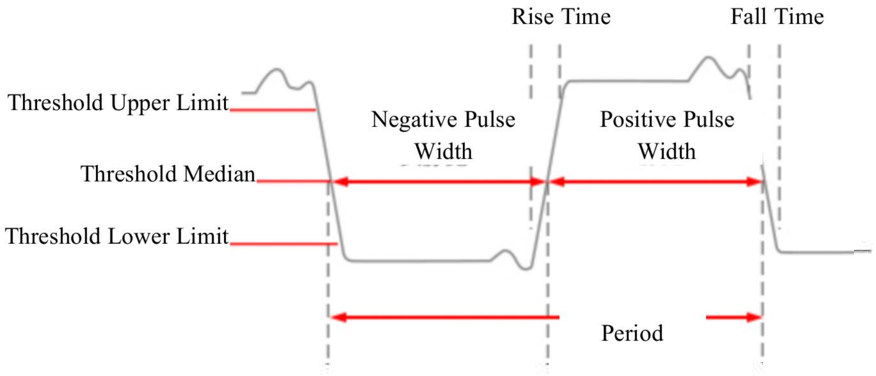


Figure 7-4 Time Parameter

Period

Time of the first complete signal cycle in the waveform

Frequency

Reciprocal to the cycle time

Rise time

Time required for the first rising edge of the waveform to rise from the amplitude of 10% to 90%

Fall time

Time required for the first falling edge of the waveform to rise from the amplitude of 10% to 90%

Delay

Time delay between rising or falling edges of channels may be measured, and there are nine effective measurement combinations

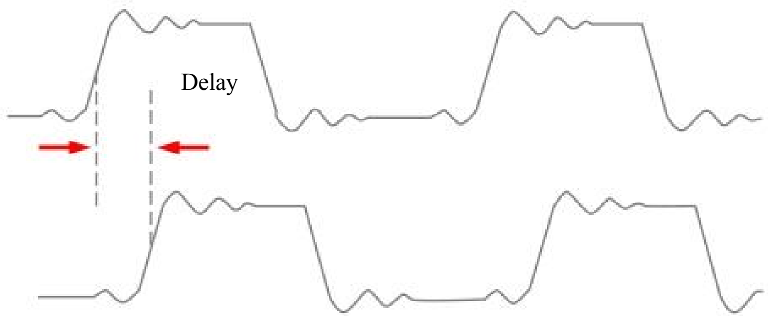


Figure 7-5 Delay Measurement Schematics

1) Open the automatic measurement menu and tap 

to pop up the phase selection menu.

2) The left channel is defaulted as the current channel, and other channels can be selected by the channel area that has been opened (except the reference channel); there are four edge selections: first rising edge, first falling edge, last rising edge, last falling edge .

3) The right channel is a contrast delay channel, which can be selected between each channel and math channel. There are four edge selections: first rising edge, first falling edge, last rising edge, and last falling edge.

4) Tap ok button to confirm.

Positive duty cycle

Measured value of the first cycle in the waveform

Positive duty cycle = (waveform positive pulse width / period) * 100%

Negative duty cycle

Measured value of the first cycle in the waveform

Negative duty cycle = (waveform negative pulse width / period) * 100%

Positive pulse width

Measured value of the first positive pulse in the waveform, taking the time between two 50% amplitude points

Negative pulse width

Measured value of the first negative pulse in the waveform, taking the time between two 50% amplitude points

Burst width

Duration of a burst measured over the entire waveform

Overshoot

Positive overshoot

Positive overshoot =[(max - high) / amplitude]*100%

Negative overshoot

Negative overshoot =[(low - min) / amplitude]*100%

Phase

Timing measurement. The amount of time that one waveform leads or lags another waveform, expressed in degrees where 360°comprises one waveform cycle.

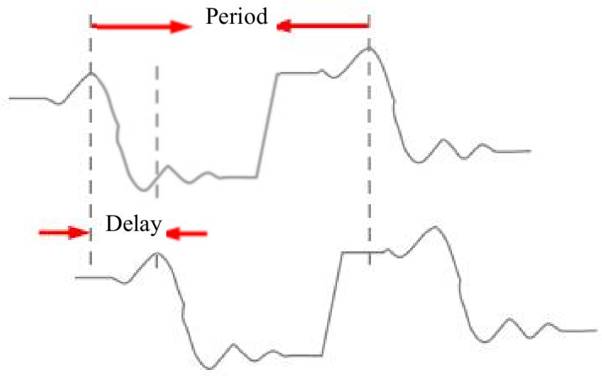


Figure 7-6 Phase Measurement Schematics

Peak-peak

In the entire waveform measurement, peak-peak = max - min

Amplitude

In the entire waveform measurement, amplitude = high (100%) - low (0%)

The figure below shows voltage measurement points.

The channel probe type setting is used to set the measurement unit for each input channel to Volts or Amperes. Refer to "5.4.4 Set Probe Type".

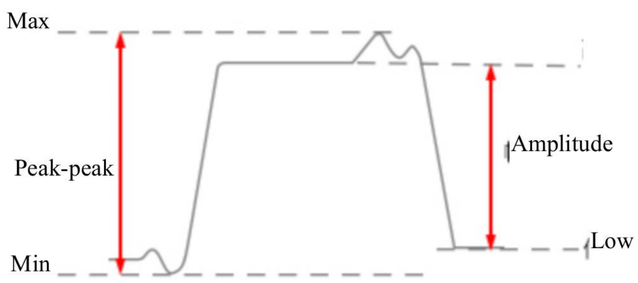


Figure 7-7 Voltage Measurement

High

Take 100% in the entire waveform, and calculated using either the min/max or histogram method.

Low

Take 0% in the entire waveform, and calculated using either the min/max or histogram method.

Max

Highest positive peak measured over the entire waveform

Min

Highest negative peak measured over the entire waveform

RMS

True root mean square value over the entire waveform

C RMS

True root mean square value of the first cycle in the waveform

Mean

Arithmetic mean over the entire waveform

C mean

Arithmetic mean over the first cycle in the waveform

Note:

If the waveform required for measurement is not fully displayed on the screen, “Forward Clipping” or “Negative Clipping” is displayed at the position of the measured value.

When the math function is operated, if source channel waveform is fully displayed, and the math waveform appears to be off the screen, the measured value of math waveform will not be influenced.

If source channel is clipped, the measured value of math waveform is the source channel value during screen wave clipping.

7.2 Frequency Meter Measurement

Open the main menu, tap Measure and Counter to enter the hardware frequency meter setting menu, and select the channel to be measured, as shown in Figure 7-8. The measured value is displayed in the upper left corner of the screen, as shown in Figure 7-9.

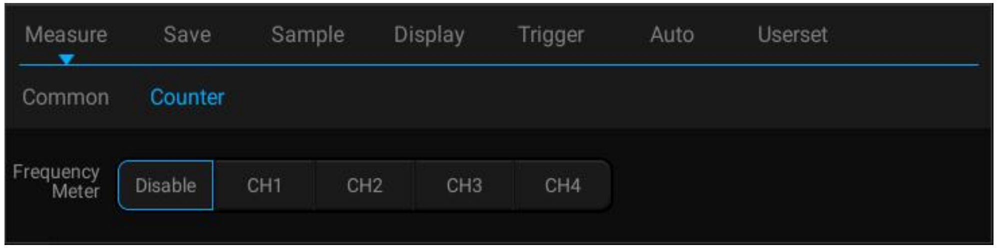


Figure 7-8 Frequency Meter Measurement Menu Open

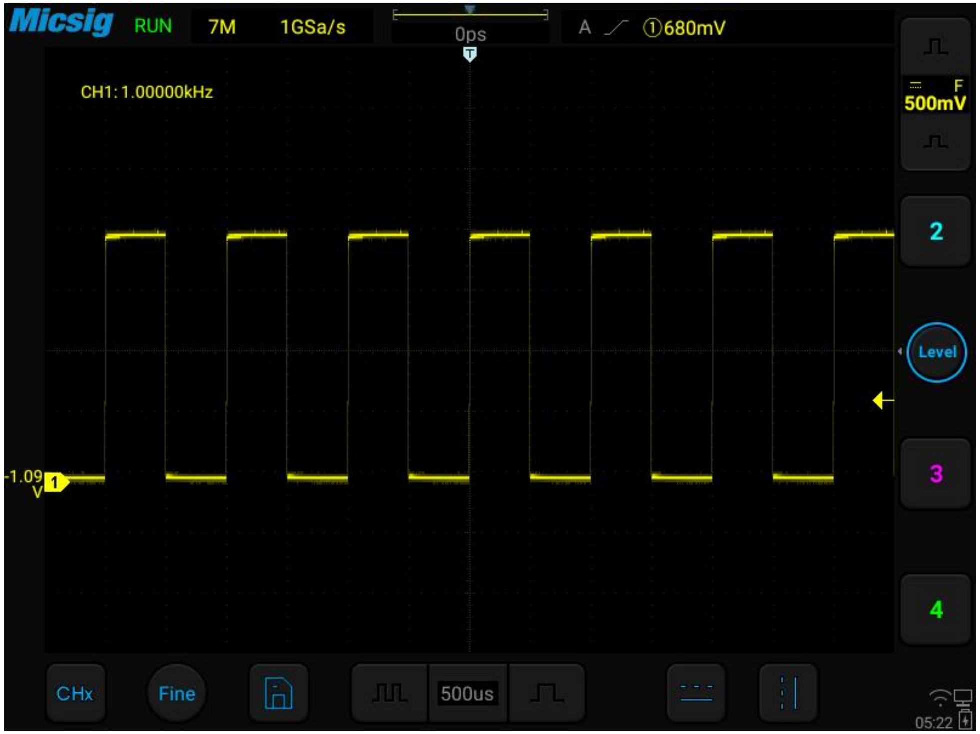


Figure 7-9 Frequency Meter Measurement

7.3 Cursor

Open cursor and place it on the measurement point to read the waveform measurement value. There are two types of cursors: horizontal cursor and vertical cursor. The horizontal cursor measures the vertical direction magnitude, and the vertical cursor measures the horizontal direction magnitude, as shown in Figure 7-10.

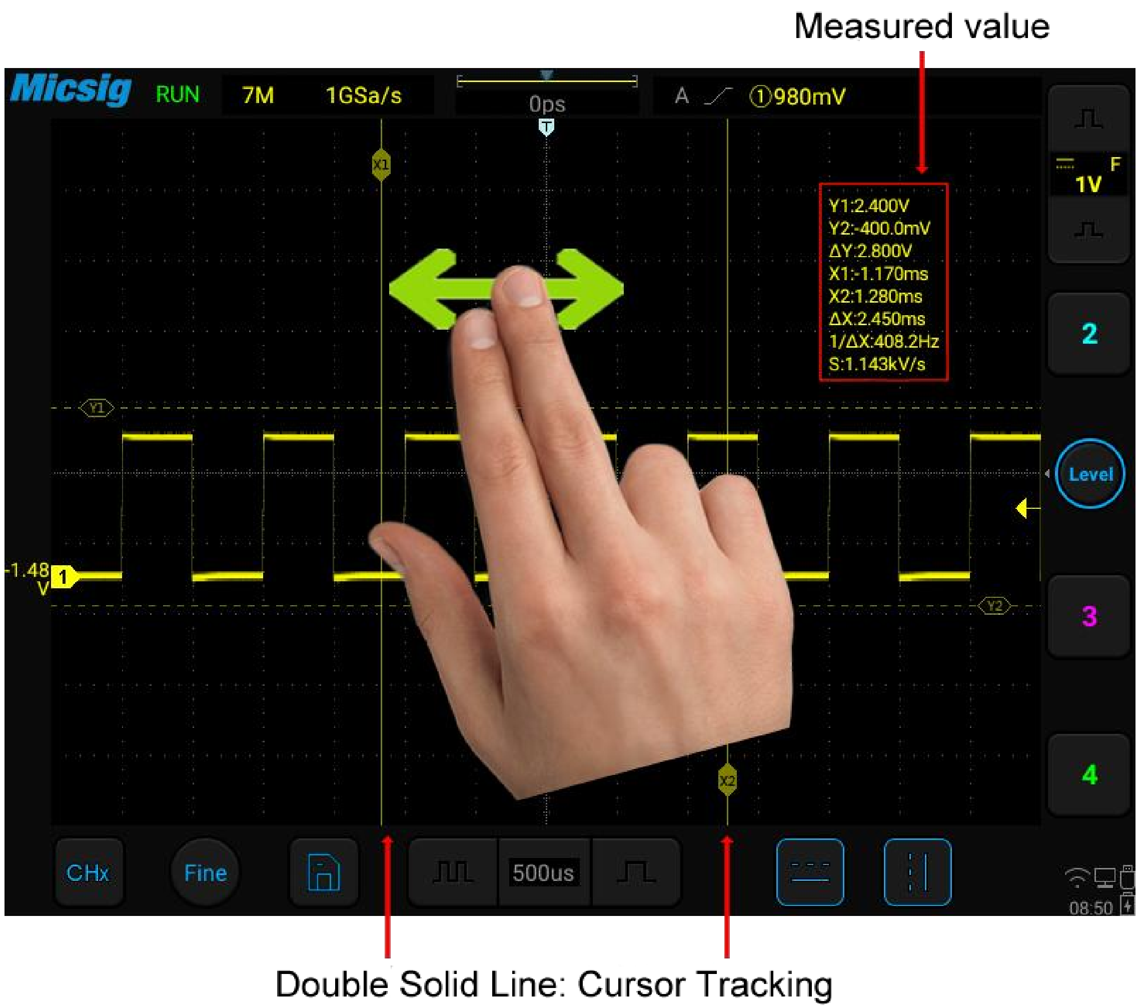


Figure 7-10 Cursor Measurement Description

Note:

△ reading: indicates the difference between two cursor positions.

Voltage readings after Y1, Y2: indicate the position of activated horizontal cursors relative to the zero potential.

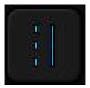
Time readings after X1, X2: indicate the position of activated vertical cursors relative to the trigger point.

1/**△X: frequency**

S reading. Indicates the quotient of △ (voltage difference) of horizontal cursors and Δ (time difference) of vertical cursors, that is, the slope of the intersection of the four cursors.

Vertical cursor on/off and activation

Vertical cursor on/off

Vertical cursor on: Tap cursor icon  to open vertical cursors and the icon is on and activated.

Vertical cursor off: Tap cursor icon  to turn off vertical cursors.

Tap the vertical cursor indicator line to switch the cursors.

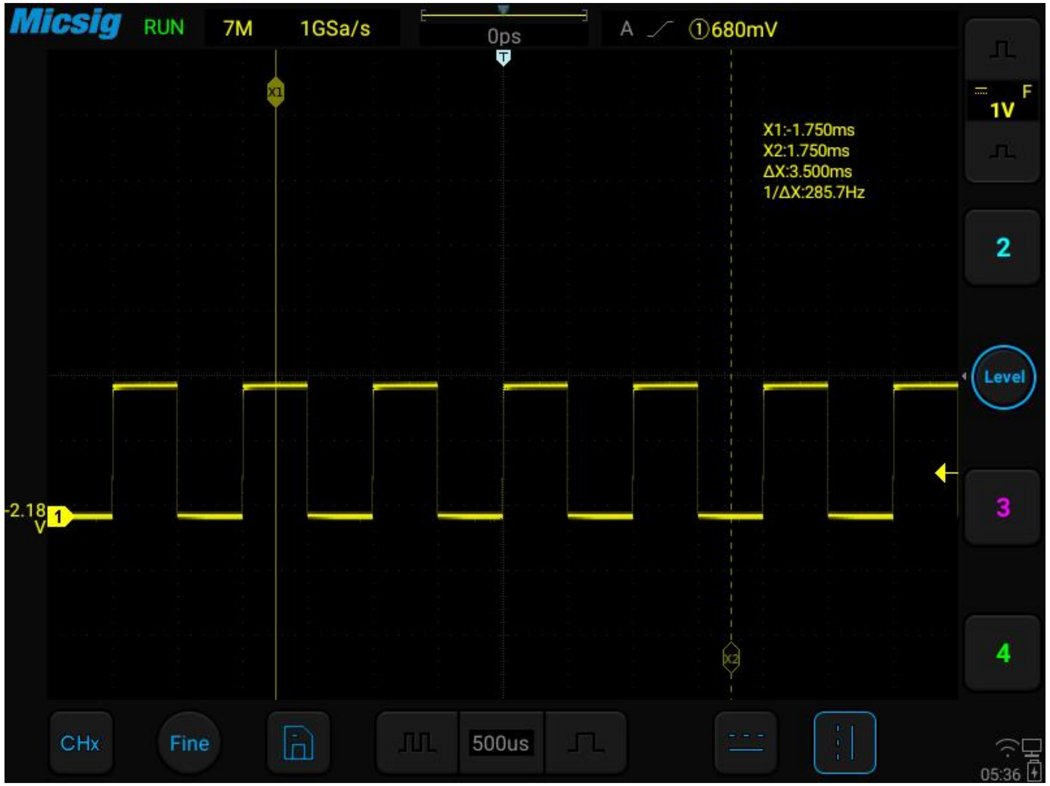


Figure 7-11 Open Cursor Selection Box and Close Cursor

Vertical cursor movement descriptions:

1) Use a single finger to press and hold the cursor indicator line on the screen to make coarse adjustment to the cursor; tap the fine adjustment button in the lower left corner of the screen to fine-adjust the cursor that has just been adjusted.

2) Cursor linkage: When the cursor is opened, two finger slide and enter the cursor linkage state.

   Note: During the sliding process, the current operation is changed unless the initial two fingers leave the screen. If one finger leaves the screen and the other finger does not leave, the current linkage adjustment is continued.

Horizontal cursor on/off and activation

Horizontal cursor on/off, switching, activation and movement operations, similar to those of vertical cursors, will not be described in detail here, and please refer to vertical cursors for details.

Cursor test example

When vertical cursors are activated, the two cursors move together to check for pulse width changes in the pulse sequence.

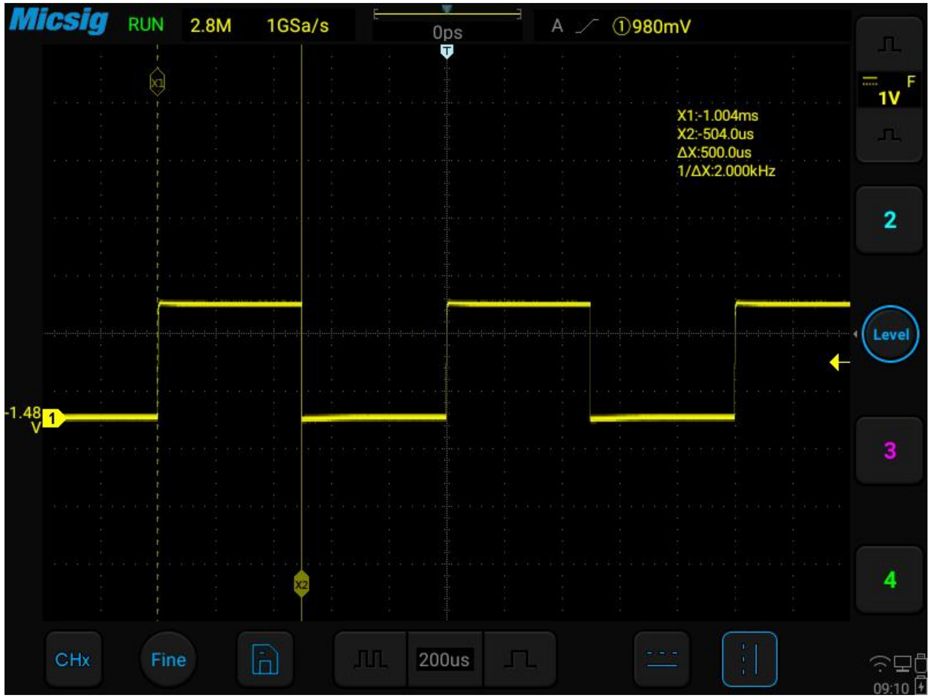


Figure 7-12 Cursor Measurement Pulse Width

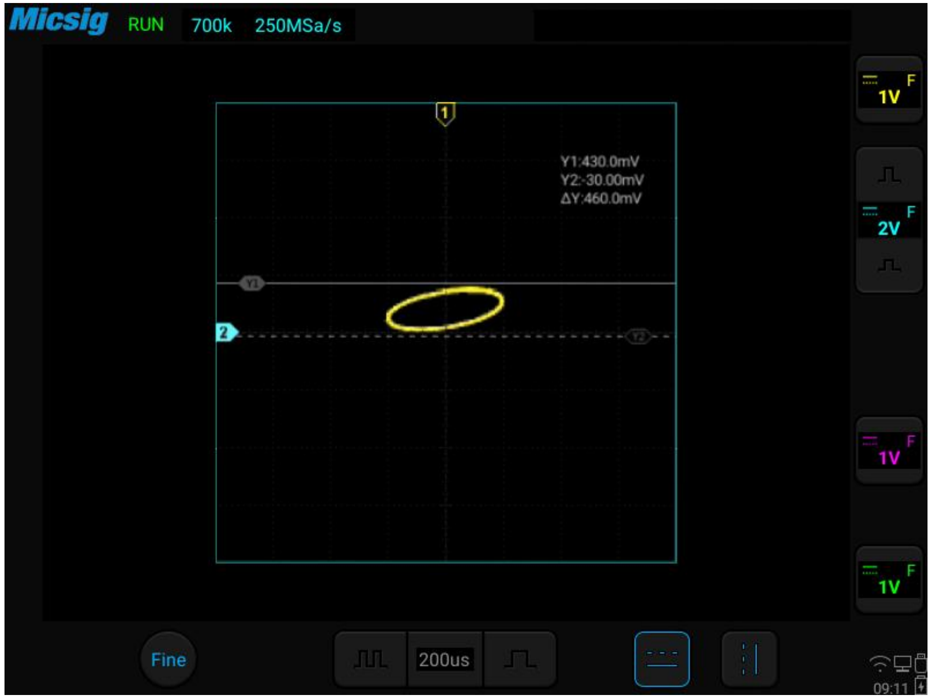


Figure 7-13 In XY Mode, Cursor Measurement

In the XY horizontal mode, X cursor displays CH1 value (V or A), and Y cursor displays CH2 value (V or A).

Chapter 8 Screen Capture, Memory Depth and Waveform Storage

This chapter contains the detailed information of the screen capture function and memory depth of the oscilloscope. You are recommended to read this chapter carefully to understand the storage system of the Smart series oscilloscope.

- Screen capture function
- Video recording
- Memory depth
- Waveform storage

8.1 Screen Capture Function

The screen capture function can locally store the display information on the current display screen in picture format.

Screen capture method: Slide upward from bottom to open pull-up menu. Tap the icon 

to have a screen capture in the oscilloscope application. Or pull down the menu in non-oscilloscope application interface twice and click the screen capture option to capture the screen content of the non-oscilloscope application.



Figure 8-1 Screen Capture

Please refer to "13.6 Picture View" for details on viewing pictures.

Timestamp and InverseColor

Invert and time-stamp screenshots is possible in oscilloscope.

Open the main menu, tap Save and enter Picture menu, turn off/on Timestamp and InverseColor button as desired.

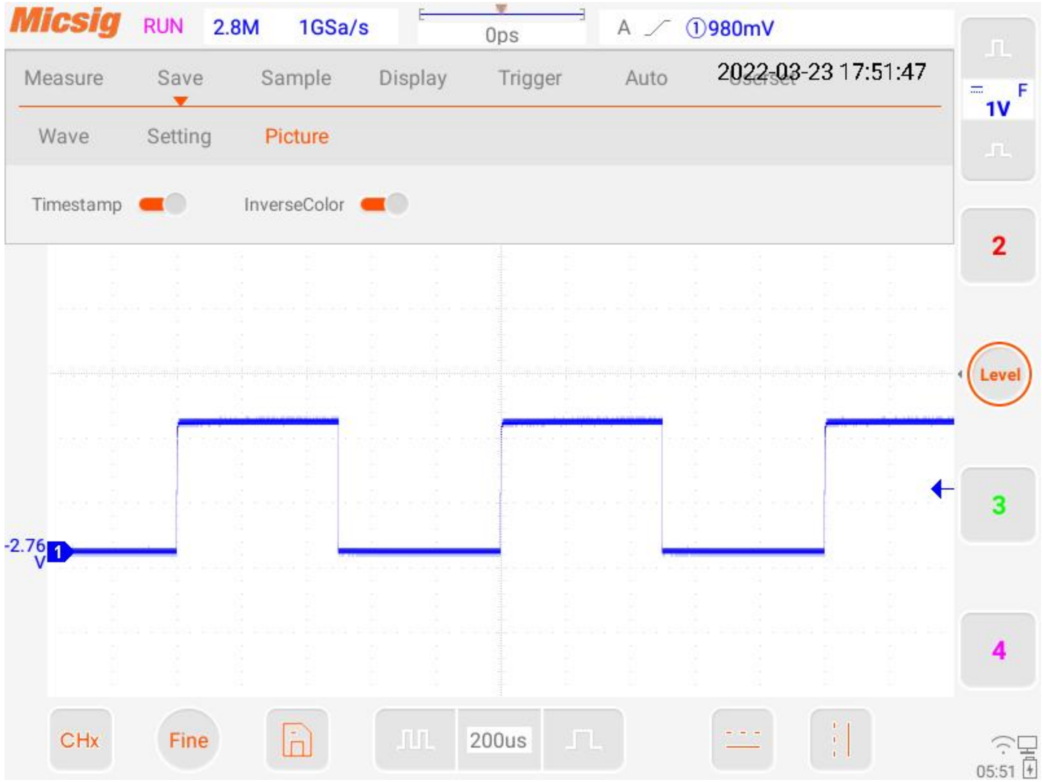


Figure 8-2 Timestamp & inverse color

8.2 Video Recording

The video recording function is similar to the screen capture function, and the display information of the current display screen can be stored locally in video format.

Video recording method is sliding down from top in non-oscilloscope application, open pull-down menu, tap the screen to start recording, and count down to three seconds to complete the video recording, as shown in Figure 8-3. You can cancel recording by pressing the triangular, circular or square button at the bottom of the screen before the countdown ends.

During video recording, you can end recording by tapping the video recording time at the top left of the screen. Or you can leave the oscilloscope application interface to open the pull-down menu, and click “Stop Recording” to end the video recording.

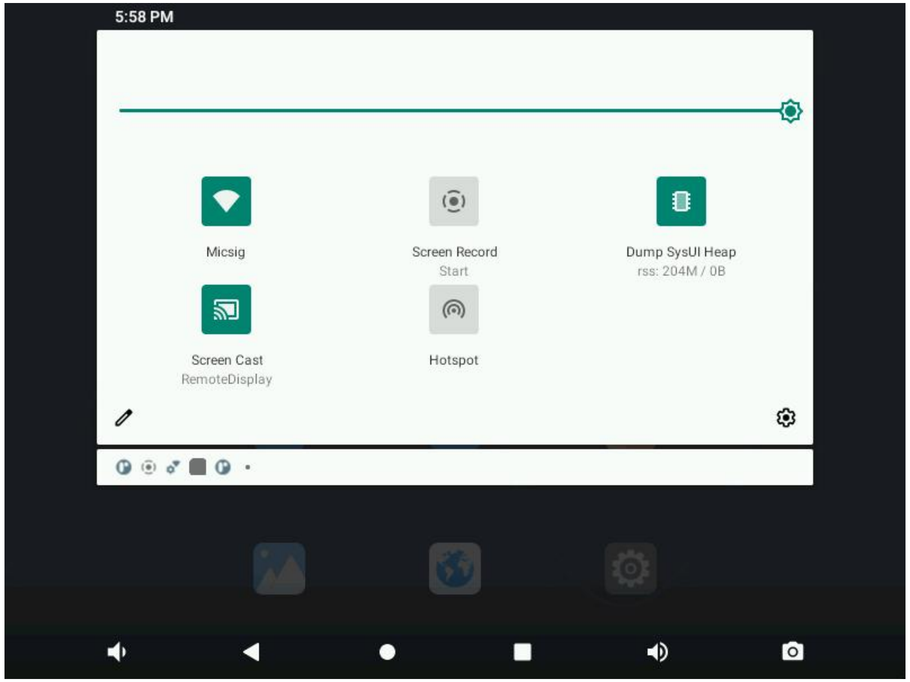


Figure 8-3 Video Recording Method

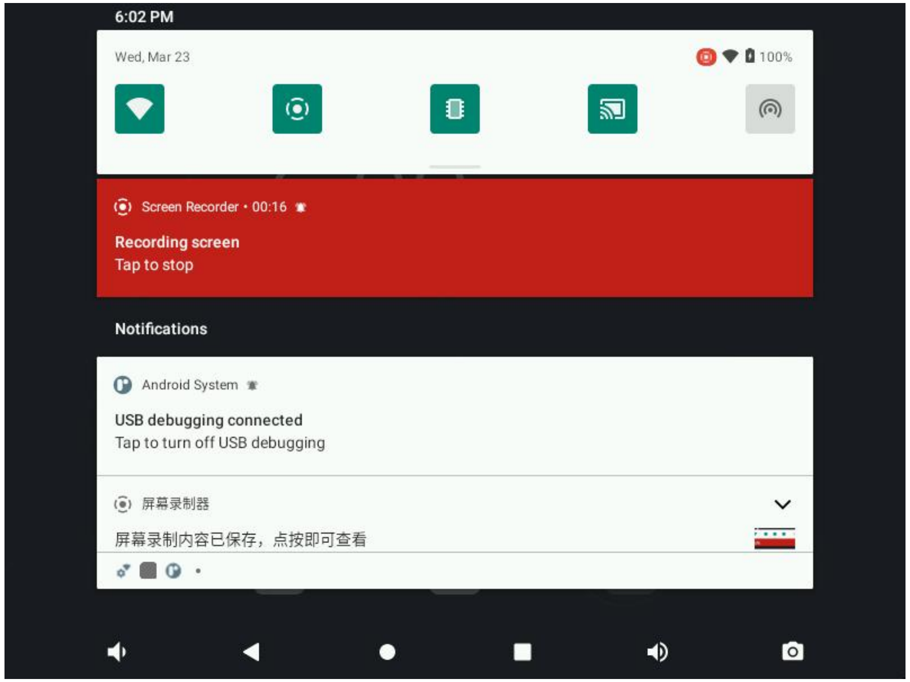


Figure 8-4 Video Recording

Please refer to "13.7 Gallery" for details of viewing videos.

8.3 Waveform Storage

The oscilloscope can save the analog channel or math channel waveform locally or in USB device. The file type can be WAV, CSV or BIN.

The oscilloscope provides four reference channels, which can be called to load WAV format files into the reference channel and open the reference channel to display the reference waveform.

Save reference file

Slide down from top, open main menu and tap "Save" to open the menu. Save the reference waveform interface of the specified channel as follows:

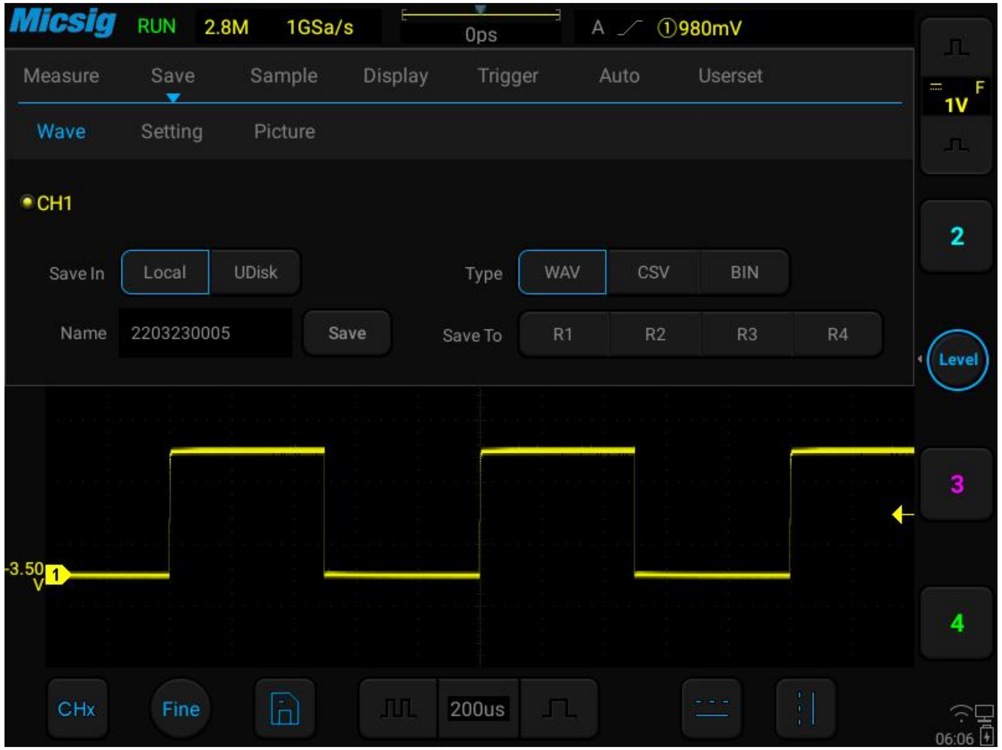


Figure 8-5 Save CH1 Reference Waveform Interface

Location: Stored locally and in USB device.

File types: WAV, CSV, and BIN.

File name: The initial file name is displayed as year + month + day + storage serial number. Press the file name box to pop up the virtual keyboard, tap “Backspace” to delete the file name, and use the virtual keyboard to rename the file.

Save: Tap to save the reference file and pop up the save success prompt. The most recently saved file will be displayed at the top of the called menu.

Save to: Tap the R* (R1, R2, R3, R4) button to save the current channel waveform directly to the corresponding reference channel, and the save success prompt will pop up.

Back: Tap to return to the previous level.

Method 1: Click the “save” button

In the Save Reference Waveform menu, select the channel waveform to be saved, select the file save location, file type and file name, and click the “save” button to save the reference waveform file.

Save the reference waveform by steps as follows:

1) The current channel is set to the channel to be saved, which can be analog channel, math channel or reference.

2) In the main menu, tap "Save" to enter the save menu.

3) In the Save menu, tap "Save" to open the Save Reference Waveform menu and make the following settings:

- Storage location: locally.
- Selecting the file type: WAV.
- Entering the file name: CH1.

4) Tap “Save” to save the reference file. The save success prompt box is popped up.

If the reference waveform file is to be saved in USB device, the oscilloscope must be connected to an external USB device. After connection, the reference waveform save location is preferentially set to the USB device.

There is no limit to the number of saved reference waveform files.

Method 2: Click R* button

In the Save Reference Waveform menu, tap R* (R1, R2, R3, R4) button to save the current channel waveform directly to the corresponding reference channel, and the save success prompt will pop up. The file name is

displayed as Ref* in the reference channel (* is the corresponding reference channel name). Reference waveform files saved by this method will be overwritten after loading other reference waveforms and cannot be restored.

Method 3: Click "Quick Save" button

Tap  at bottom of the screen to save all channel waveforms as reference waveforms and capture the current screen. The file names are the default initial file names.

Management of reference files

In the file manager, open waveforms in the classification file to manage reference files by operations such as copy, cut, delete, rename, compress, etc., as shown in Figure 8-4. Select reference files and click trash button to delete them; click More at bottom of the screen, tap Rename to open soft keyboard and change the reference file name. Tap Compress to pop up the soft keyboard and enter the compressed file name to compress the file; when inserting the USB device, files on the oscilloscope can be moved to the USB device.

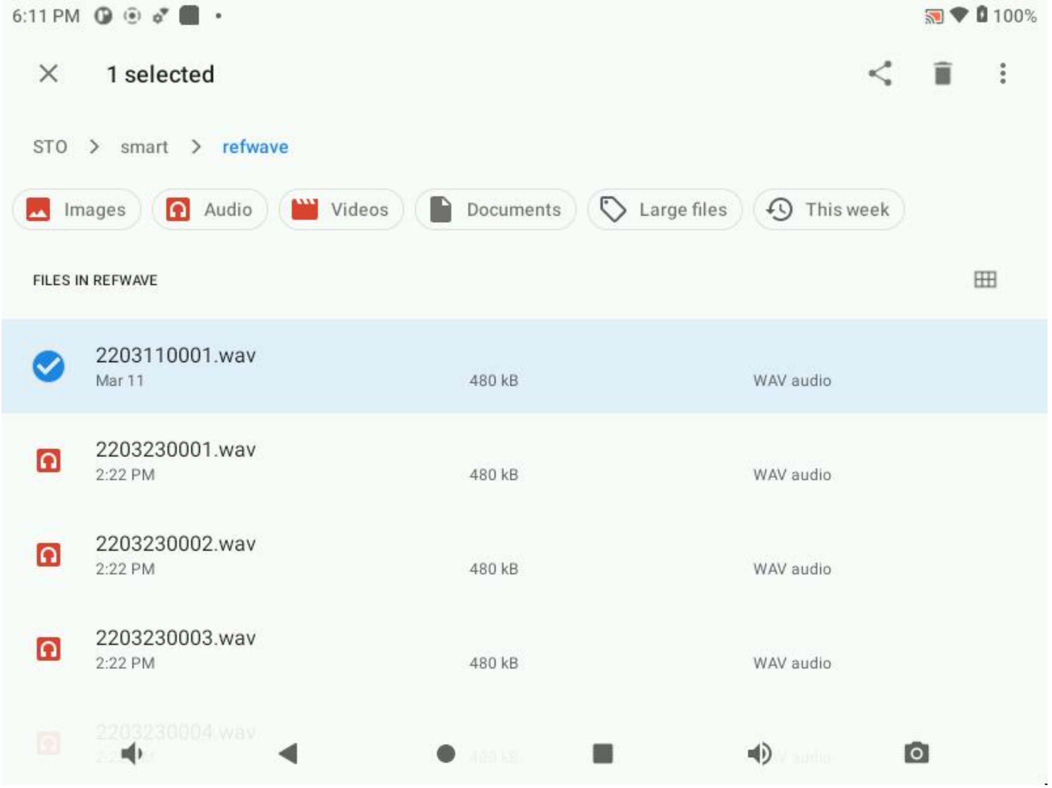


Figure 8-6 Delete Reference Files

CSV files

CSV file structure

CSV format contains the basic information of the saved data: save time, file name, data length, sampling interval, trigger time, source, vertical scale, vertical offset, vertical accuracy, horizontal time base, horizontal accuracy, probe multiples.

The data and length of CSV files can be saved up to 70K/35K depending on the single/dual channel while being saved. If the oscilloscope record length or the displayed data length is less than 70K/35K, the data length of CSV files changes either. For example, when the record length is set to 14/7/3.5K, there will be 7000 sample points in the dual channel CSV file.

Max and Min in CSV files

If running Min or Max measurements, Min and Max values displayed on the measurement results screen may not appear in CSV files.

Explanation: If the oscilloscope sampling rate is 1GSa/s, sampling will be once every 1ns. If the horizontal scaling is set to 10us/div, the data of 140us will be displayed (because there are 14 divisions on screen). To find the total number of samples, the oscilloscope will perform: 140us×1GSa/s=140K sampling, which require the oscilloscope

to display 140K times of sampling using 600-pixel columns. The oscilloscope extracts 140K samples into 600-pixel columns, and this extraction will track Min and Max values of all points represented by any given column. These Min and Max values will be displayed in this screen column.

The similar process is applied to reduce sampled data and produce records that can be used to perform various analyses, such as measurements and CSV data. This analysis record (or measurement record) is much larger than 600 and may actually contain up to 60,000 points. However, once the number of points sampled exceeds 60,000, some extraction method is required. The extraction factor used to generate the CSV record is configured to provide the best estimate of all samples represented by each point in the record. Therefore, Min and Max values do not appear in CSV files.

8.4 Oscilloscope setting save

The oscilloscope supports saving up to 10 current settings and restoring them with one key.

Open the main menu, tap Save and enter Setting menu, as shown in Figure 8-7.

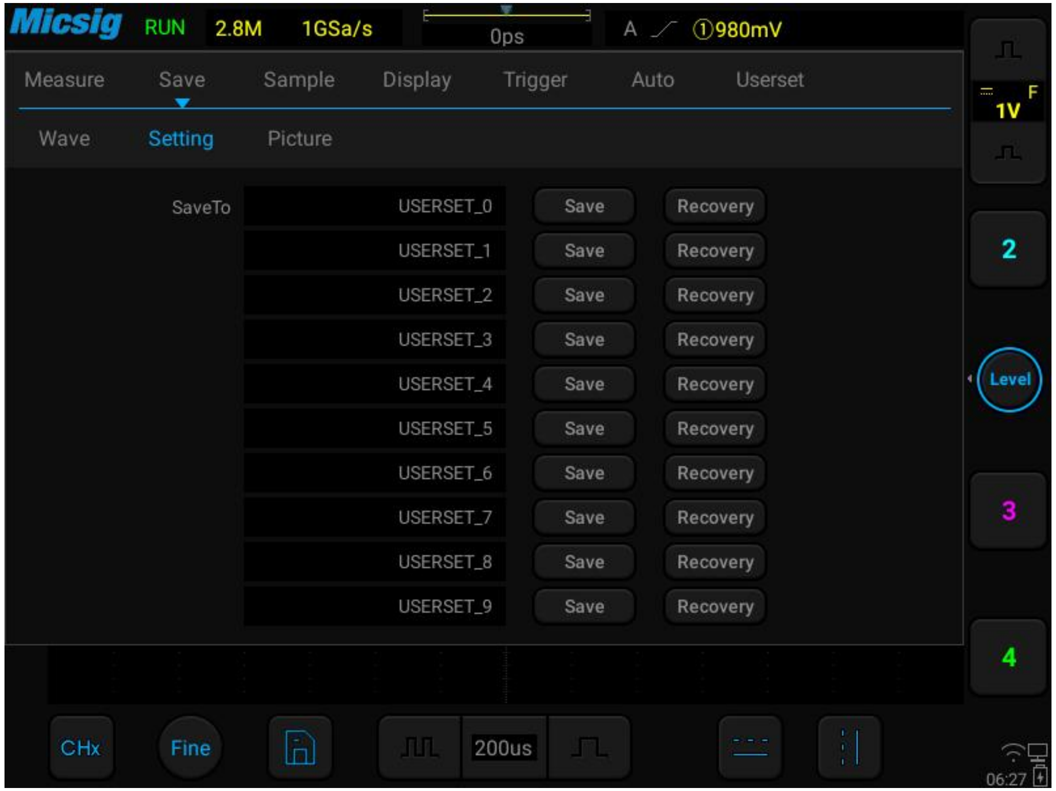


Figure 8-7 oscilloscope setting save

Tap the black box area to rename save settings, tap the Save button to store, the Recovery button to restore the settings.

Chapter 9 MATH and Reference

This chapter contains the detailed information of the MATH operation and reference channel of the oscilloscope. You are recommended to read this chapter carefully to understand the setting functions and operations of the MATH and reference channels of the Smart series oscilloscope.

- Dual waveform calculation
- FFT measurement
- Reference waveform call

9.1 Dual Waveform Calculation

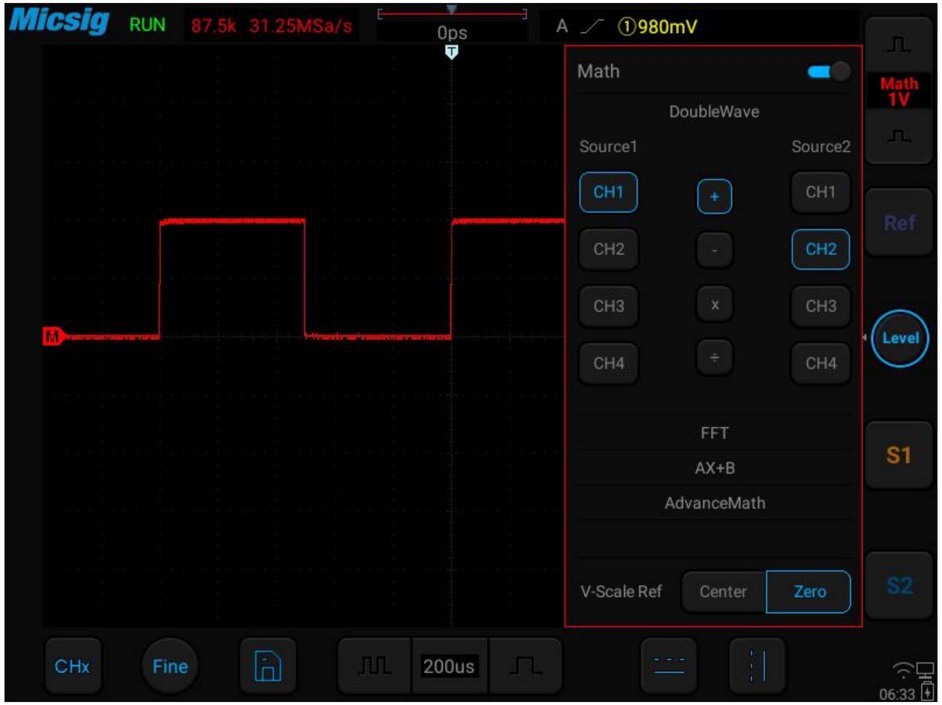


Figure 9-1 MATH Channel Waveform

Display math waveform

Swipe up or down at the channel selection area to enter the second channel selection area. Tap the soft key 

to open the math channel. After the math waveform is opened, the current channel selector is automatically opened.

Left swipe math channel icon to open the math channel menu. While opening math for the first time, the math operation is defaulted as the dual channel calculation.

Math operation prompt

If the analog channel or math function is clipped (not fully displayed on the screen), the resulting math function will also be clipped.

Once the math waveform is displayed, tap the channel icon to close the source channel for a better view of the math waveform.

The vertical sensitivity and offset of each channel participating in the math function can be adjusted to facilitate viewing and measuring of the math waveform.

The math function waveform can be measured using “Cursor” and “Measure”.

Adjust the math waveform

1) Press the math channel vertical sensitivity icon, directly tap the math waveform or math channel indication icon M▷, and set the math channel as the current channel.

2) For details of movement, vertical sensitivity adjustment, time base adjustment and vertical expansion reference of the math channel, please refer to "Chapter 4 Horizontal System" and "Chapter 5 Vertical System".

3) The vertical sensitivity, unit and time base corresponding to the math waveform are displayed in the channel area of the math channel. For details, see "2.7 Understand the Oscilloscope Display Interface".

Math waveform units

Use "Probe Type" on the channel menu to adjust the channel unit (refer to "5.4.4 Set Probe Type") and set the unit of each input channel to Volt or Ampere. The units of math function waveform include:

Math Function	Unit
+ / –	V, A, ?
×	VV, AA, W
÷	V/V, V/A, A/A, A/V

Table 9-1 List of Mathematical Units

Note: If the units of two operation source channels are different and the unit combination cannot be identified, the unit of math function will be displayed as? (undefined).

Math operators

Math operators perform arithmetic operations on the analog input channels.

Addition or subtraction

If addition or subtraction is selected, the values of function sources 1 and 2 will be added or subtracted point by point and the results will be displayed.

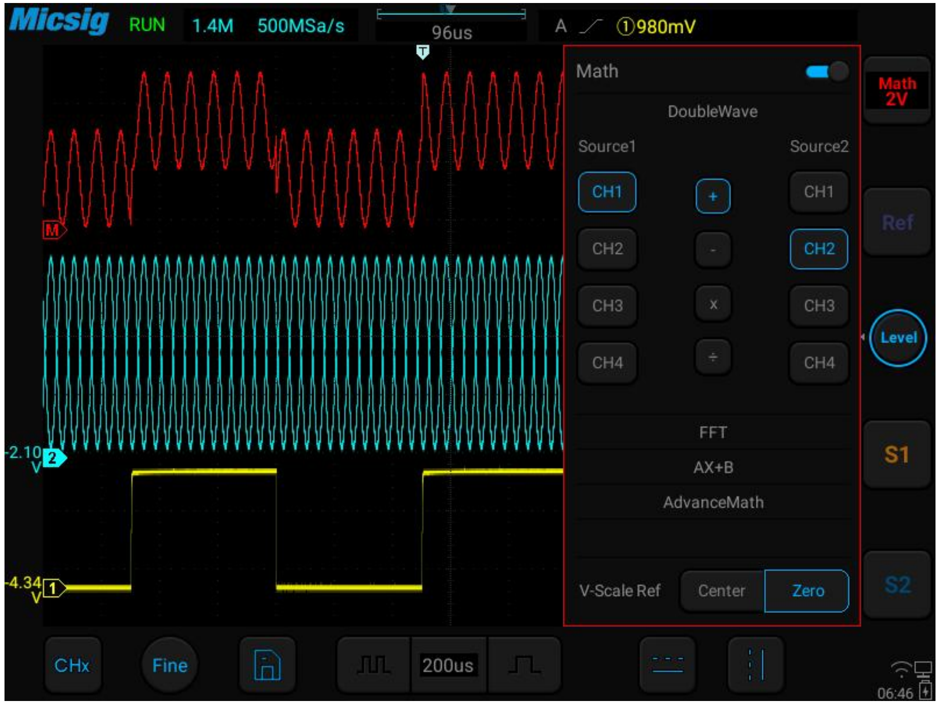


Figure 9-2 Mathematical Operation of CH1 adding CH2

Multiplication or division

When multiplication or division is selected, the values of function sources 1 and 2 values will be multiplied or divided point by point and the results will be displayed.

Multiplication is useful when viewing the power relationship, if one of the channels is proportional to the current.

9.2 FFT Measurement

FFT is used to calculate the Fast Fourier Transform using the analog input channel. FFT record specifies the digitization time of the source and converts it to the frequency domain. After selecting the FFT function, FFT spectrum is plotted as amplitude in V-Hz or dB-Hz on the oscilloscope display screen. The reading of the horizontal axis changes from time to frequency (Hz), while the unit of the vertical axis changes from volt to V or dB.

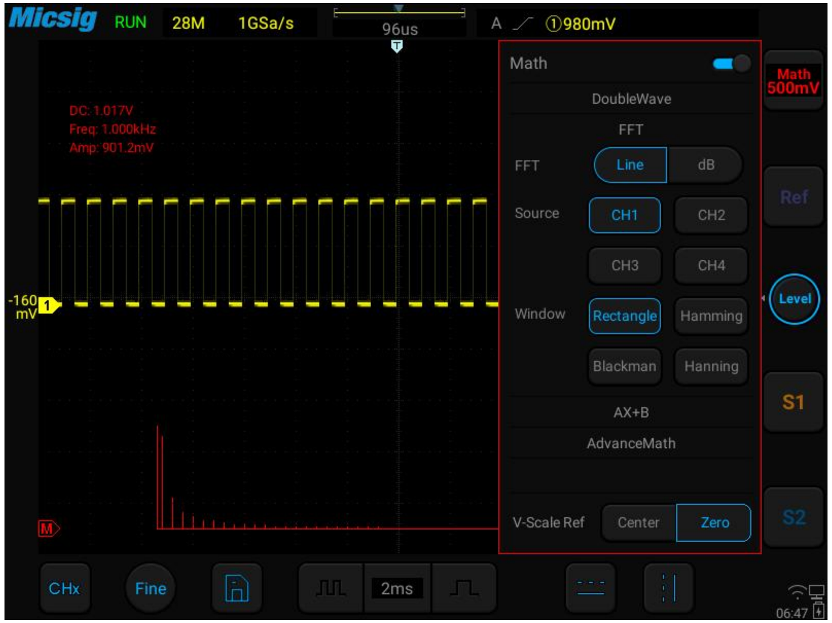


Figure 9-3 FFT Window

Open FFT

1) Swipe up or down at the channel selection area to enter the second channel selection area. Tap the soft key **Math** to open the math channel, left swipe to open math channel menu.

2) Tap **FFT** spectrum type “Line/Decibel” to open the FFT window (see Figure 9-3 FFT Window).

3) Tap the Operation Source box to select the channel for which FFT transform is required.

4) Tap the window box to select the window function applied to the FFT input signal.

Selection of window function

In the FFT transform, four different FFT windows can be selected.

Each window is alternatively used between frequency resolution and amplitude accuracy, and the appropriate window may be selected according to the characteristics of the following windows.

- **Rectangular window**

This is the best window type for resolution frequencies that are very close to the same value, but this type is the least effective at accurately measuring the amplitude of these frequencies. It is the best type of measuring the spectrum of non-repetitive signals and measuring the frequency component close to DC.

Use the "Rectangular" window to measure transients or bursts of signal levels before or after almost the same event. Moreover, this window can be used to measure equal-amplitude sine waves with very close frequencies and wideband random noises with relatively slow spectral variations.

- **Hamming window**

This is the best window type for resolution frequencies that are very close to the same value, and the amplitude accuracy is slightly better than the "Rectangular" window. The Hamming type has a slightly higher frequency resolution than the Hanning type.

Use Hamming to measure sinusoidal, periodic, and narrowband random noises. This window is used for measuring transients or bursts of signal levels before or after events with significant differences.

- **Hanning window**

This is the best window type for measuring amplitude accuracy but less effective for resolving frequencies.

Use Hanning to measure sinusoidal, periodic, and narrowband random noises. This window is used for measuring transients or bursts of signal levels before or after events with significant differences.

- **Blackman-Harris window**

This is the best window type for measuring frequency amplitude, but worst for measuring the resolution frequency.

Use the Blackman-Harris measurement to find the main single-signal frequency waveform for higher harmonics.

Since the oscilloscope performs FFT transform on the finite-length time record, the FFT algorithm assumes that YT waveform is continuously repeated. Thus, when the period is integral, the amplitudes of YT waveform at the beginning and at the end are the same, and waveform will not interrupt. However, if the period of YT waveform is not integral, the waveform amplitudes at the beginning and at the end are different, resulting in high-frequency transient interruption at the junction. In the frequency domain, this effect is called leakage. Therefore, to avoid leakage, the original waveform is multiplied by a window function, forcing the values at the beginning and at the end to be zero.

Note: Signals with DC components or deviations can cause errors or deviations in the FFT waveform components. AC coupling can be selected to reduce DC components.

Spectrum type

Select Line, the vertical axis reads V or A; select dB, the vertical axis reads dB. When the spectrum is linear, the waveform is shown in Figure 9-4.

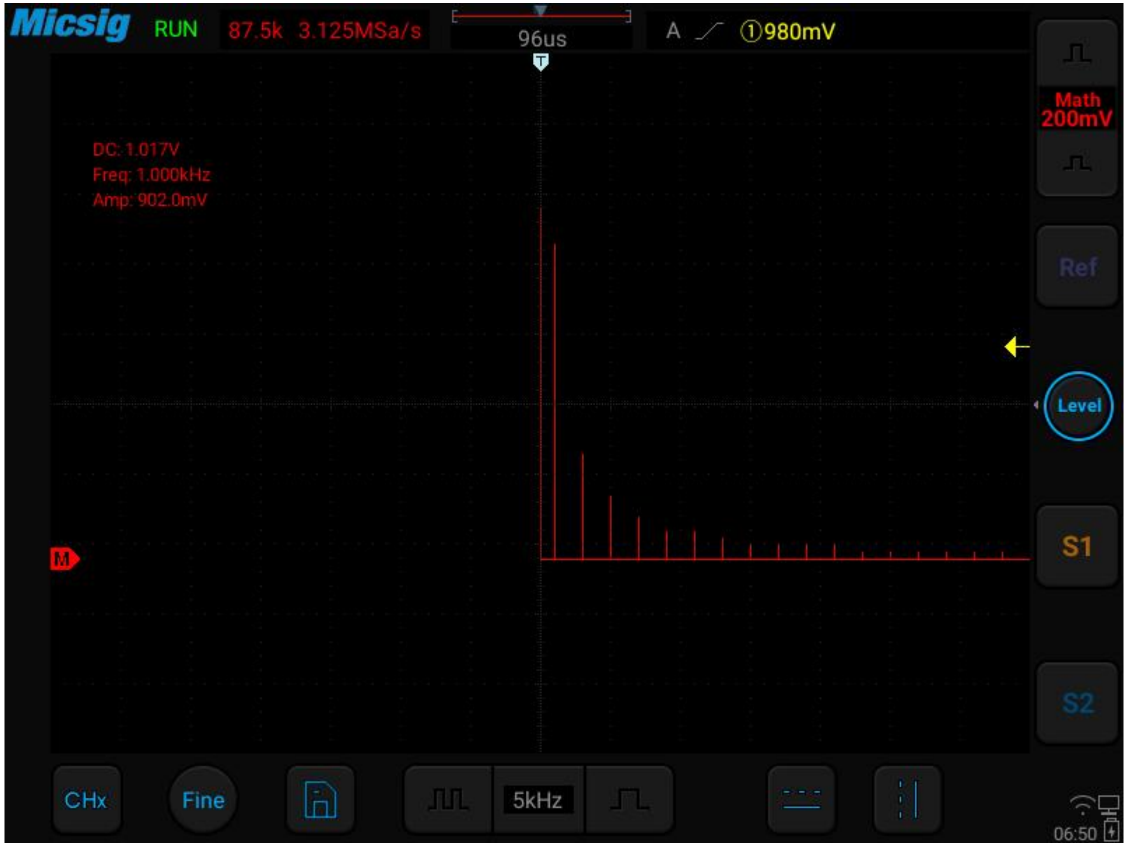


Figure 9-4 Spectrum Amplitude as V-Hz

Adjust FFT waveforms

Waveform position

- Select math channel as the current channel. After touching math waveform on the screen with one finger, adjust the waveform display position by dragging upward and downward, leftward and rightward, or tap the fine adjustment button in the lower left corner of the screen for fine adjustment

- Select math channel as the current channel and press the “position” knob in the horizontal button area to move the leftmost side of the waveform (0Hz) to the horizontal center of the screen.

- Select math channel as the current channel and press the “position” knob in the vertical button area to move the waveform to the vertical center of the screen.

Horizontal time base scale

Select math channel as the current channel, tap the time base adjustment button, and adjust the horizontal time base scale. The horizontal time base is stepped in 1-2-5, and the waveform changes either.

For FFT measurement, the reading of the horizontal axis changes from time to frequency (Hz), and it no longer shares the same time base with other analog channels. Therefore, before adjusting the horizontal frequency scale, the math channel must be set as the current channel.

Vertical sensitivity

Tap  or  on the right side of the screen to set the vertical sensitivity (V/div or dB/div) for the channel so that waveform is displayed on the screen at an appropriate size. The vertical sensitivity factor is stepped in 1-2-5 (using 1:1 probe).

Note: FFT waveform does not support automatic parameter measurement.

9.3 Reference Waveform Call

Reference waveform call and close

Swipe up or down at the channel selection area to enter the second channel selection area. Left swipe 

button to open the reference menu, see Figure 9-5.

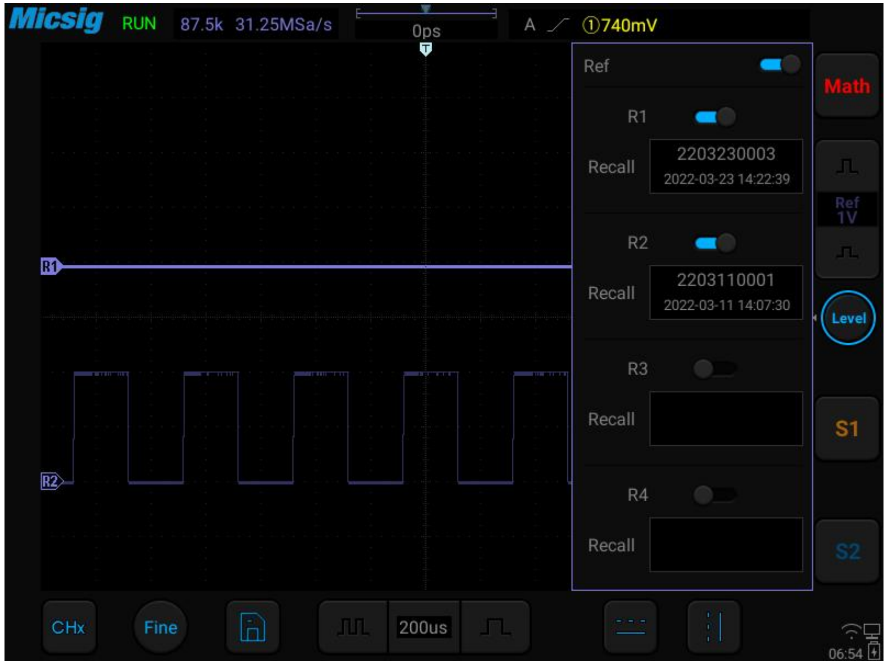


Figure 9-5 Reference Channel Menu

When there are already waveforms loaded into the reference channel, click "Open/Close" button to open or close the reference channel; the reference waveform is displayed in blue-violet, and the four stored waveforms can be displayed simultaneously, wherein the current reference waveform is brighter than non-current reference waveforms.

When there are no waveforms loaded into the reference channel, turn on the "Call" switch to call waveforms.

Take R1 as an example, with operation steps as follows:

1) Open reference menu.

2) Tap the “Call” file box under R1 to open the reference file column.

3) Click the name of the reference waveform file to be called. The file is loaded into R1 channel. Then, R1 channel is turned on as the current channel waveform, and the reference waveform channel icon 

is highlighted. The displayed state changes from “Close” to “Open”. As in Figure 9-6, the brighter reference waveform is shown as the current reference channel.

If there are already files loaded into the reference channel, tap 

to open the reference channel of all loaded reference files; Right swipe 

to close all currently opened reference waveforms. A single reference channel may also be opened with the Open/Close button.

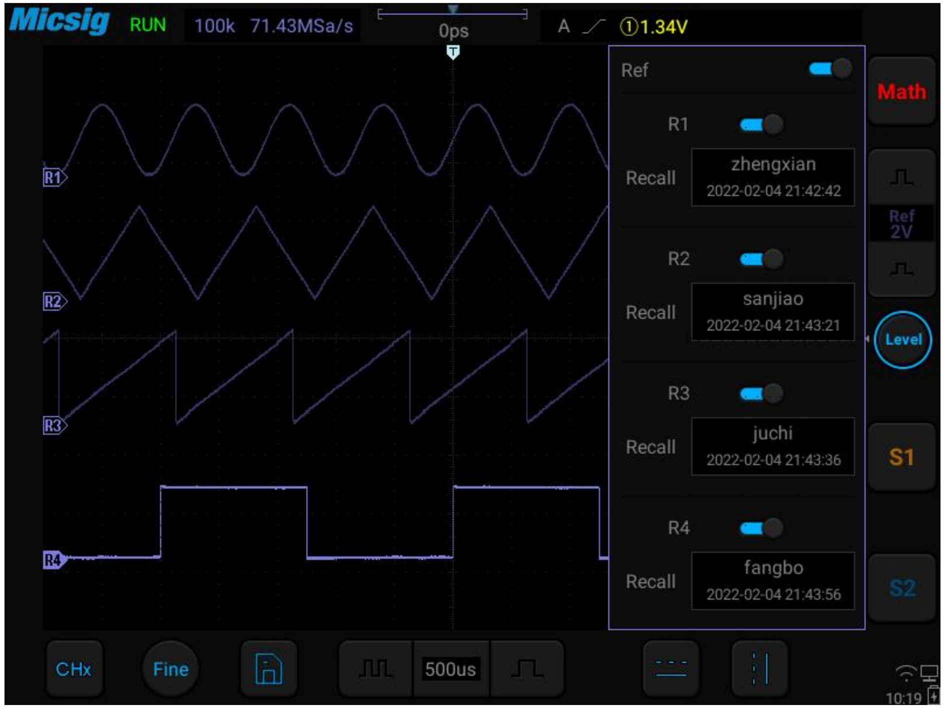


Figure 9-6 Restore Reference Waveform

Close the reference waveform:

1) In the reference menu, tap "Open/Close" button in R1 to close the reference waveform.

2) Repeat step 1 to close other reference channels.

3) Right swipe 

to turn off all reference waveforms.

Reference waveform movement and time base adjustment

The horizontal or vertical movement and zoom of reference waveforms are independent of analog channels, and the adjustments among different reference waveform channels are also independent of each other.

To adjust the reference waveform of a channel, first set the channel as the current channel, and then adjust the reference waveform by move or zoom (in accordance with the analog channel method).

The scale and time base of the current channel reference waveform are displayed on the reference button. After switching the current reference channel, the scale and time base on the reference button change with the change of current reference channel.

Chapter 10 Display Settings

This chapter contains the detailed information of the display settings and function buttons of the oscilloscope. You are recommended to read this chapter carefully to understand the display setting functions and operations of the Smart series oscilloscope.

- Waveform setting
- Graticule setting
- Color temperature setting
- Persistence setting
- Horizontal expansion center
- Time base mode selection

In the main menu, tap Display button to enter display settings menu, as shown in Figure 10-1.



Figure 10-1 Display Settings and Function Buttons

10.1 Waveform Settings

Open the display menu, tap Waveform button to open the waveform display menu. This menu is used to set the display mode and brightness of waveform. The waveform display mode is divided into two types: dots and vectors. The waveform brightness percentage is adjustable, and the waveform display setting is shown in Figure 10-2.

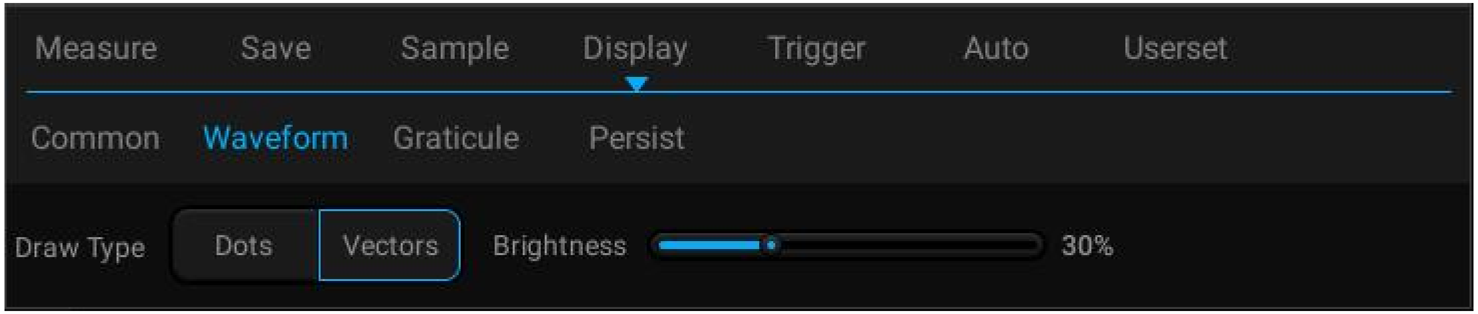


Figure 10-2 Waveform Display Menu

10.2 Graticule Setting

Open the display menu and tap Graticule button to open the graticule setting menu (Figure 10-3). Graticule display mode includes: “Full”, “Grid”, “Crosshair” and “Frame”, and the brightness percentage is adjustable.

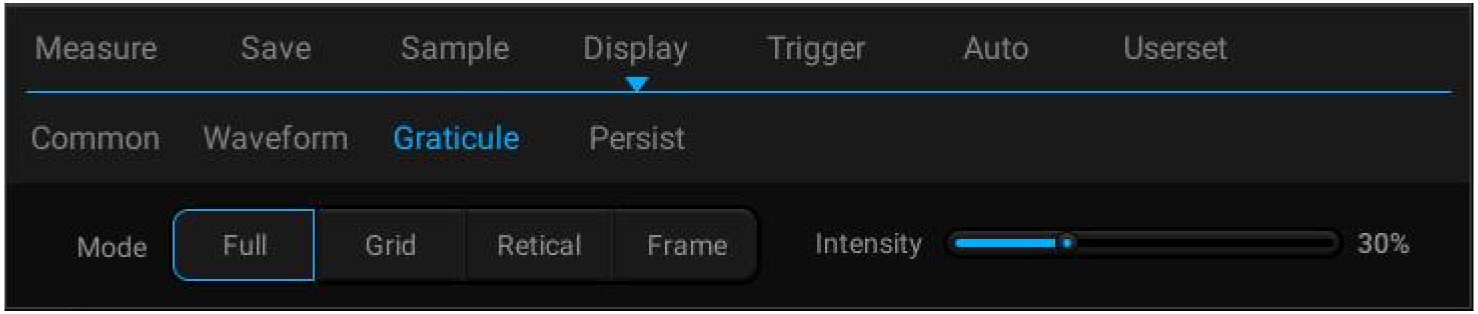


Figure 10-3 Graticule Menu Display

10.3 Persistence Setting

Open the display menu and tap Persist key to open the persistence settings menu.

1) Persistence setting

In the persistence setting menu, select:

- **None:** None - no persistence.
- **Auto:** Auto — automatic persistence.

- **Normal:** Normal - set the persistence time — After selecting the variable persistence, tap the box on the right of "Adjust" to pop up the persistence time selection box (Figure 10-4) and set the persistence time. It can be set between 10ms and 10s.

- ∞**:** Infinite persistence - never erase the results of previous acquisitions

  Infinite persistence can be used to measure noise and jitter, display the worst-case extremes of varying waveforms, find time violations, capture events that occur infrequently.

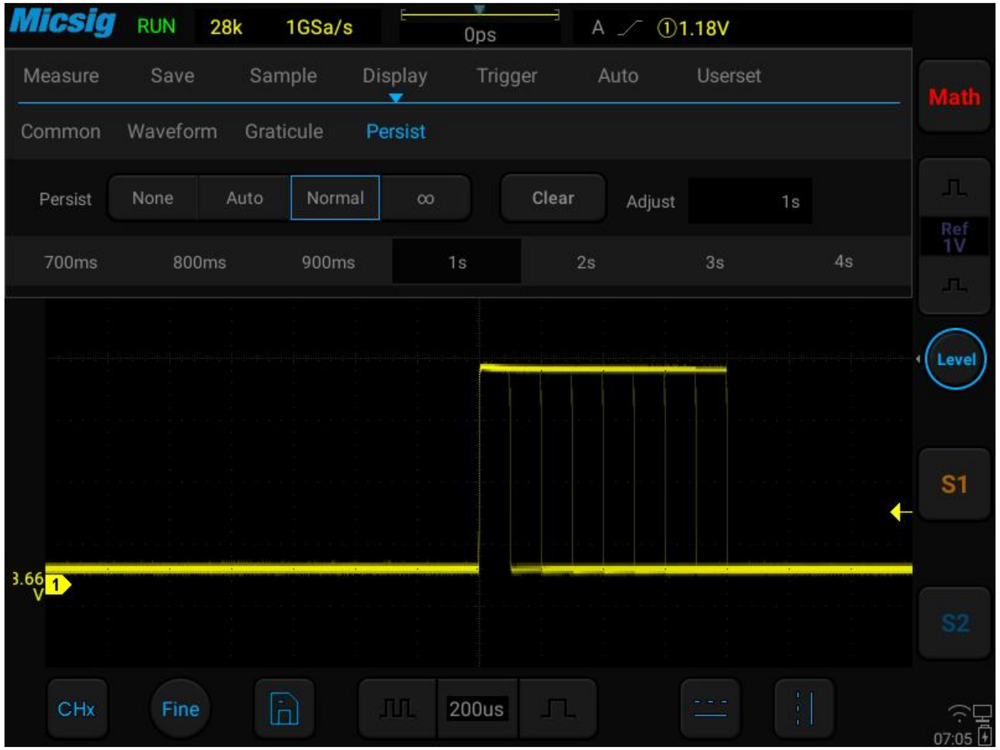
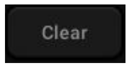


Figure 10-4 Persist time adjust

2) Erase persistence

To erase the previously acquired results from the display, tap 

key or adjust the horizontal time base and vertical sensitivity. The oscilloscope will erase the persistence display and start the cumulative acquisition again.

10.4 Horizontal Expansion Center

Horizontal expansion is divided into two types: screen center and trigger position:

1) Screen center

Select "Center" to adjust the time base waveform to expand or contract toward both sides with the screen center as the base point, and the delay time does not change.

2) Trigger position

Select "TrigPos" to adjust the time base waveform to expand or contract toward both sides with the trigger position as the base point. The delay time varies with the horizontal time base.

10.5 Color Temperature Setting

Turn on the color temperature mode, and the waveform display is shown in Figure 10-5;

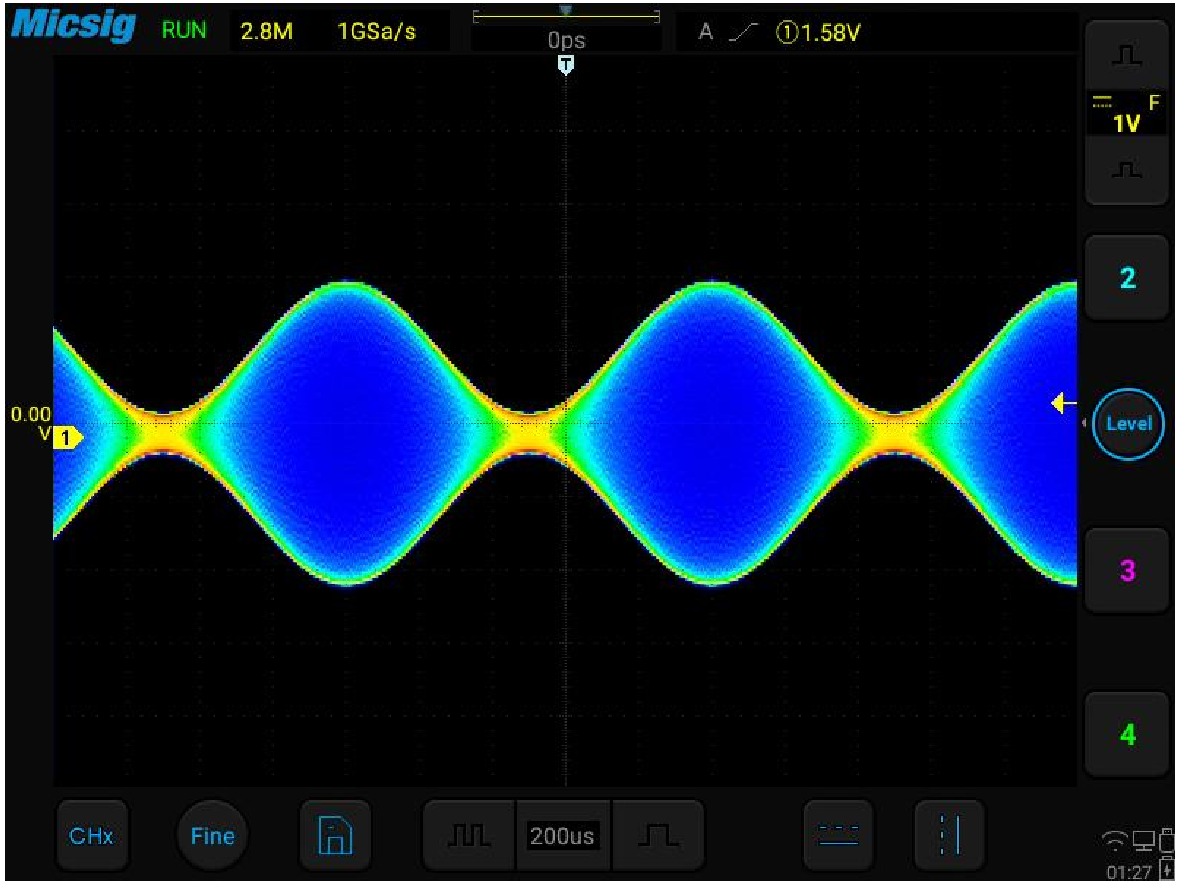


Figure 10-5 Color Temperature Open Mode

10.6 Time Base Mode Selection

For details, please refer to "4.4 ROLL, XY" in Chapter 4.

Chapter 11 Sampling System

This chapter contains the detailed information of the sampling system of the oscilloscope. You are recommended to read this chapter carefully to understand the setting and operation of the sampling system of the Smart series oscilloscope.

- Sampling overview
- Run, stop and single sequence acquisition (running control)
- Select sampling mode
- Record length and sampling rate

11.1 Sampling Overview

To understand the sampling and sampling modes of the oscilloscope, you need to understand the sampling principle, aliasing, oscilloscope bandwidth and sampling rate, oscilloscope rise time, required oscilloscope bandwidth, and the influence of memory depth on the sampling rate.

Sampling principle

According to the Nyquist sampling principle, for a bandwidth-limited signal with the maximum frequency f_{MAX}, the equidistant sampling frequency f_S must be twice as large as the maximum frequency f_{MAX}, so that a unique signal can be reconstructed without aliasing.

$$f_{MAX} = \frac{f_S}{2} = \text{Nyquist frequency } f_N = \text{alias frequency}$$

Aliasing

Aliasing occurs when the signal is under sampled ($f_S<2f_{MAX}$). Aliasing is signal distortion caused by incorrectly reconstructing low frequencies from a small number of sampling points.

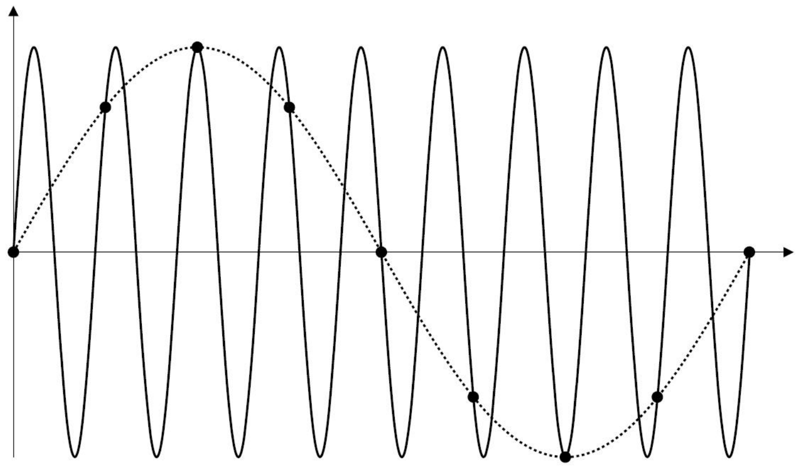


Figure 11-1 Aliasing

Oscilloscope bandwidth and sampling rate

The oscilloscope bandwidth usually refers to the lowest frequency at which the input signal sine wave is attenuated by 3dB (-30% amplitude error).

For oscilloscope bandwidth, according to the sampling principle, the required sampling rate is $f_S=2f_{BW}$. However, this principle assumes that there is no frequency component exceeding f_{MAX} (f_{BW} in this case) and requires a system with ideal brick-wall frequency response.

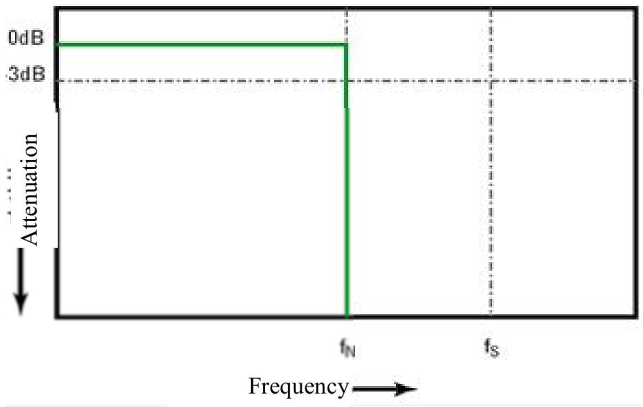


Figure 11-2 Theoretical Brick-Wall Frequency Response

However, digital signals have frequency components that exceed the fundamental frequency (the square wave consists of sine waves at fundamental frequency and an infinite number of odd harmonics), and for bandwidths of 500MHz and below, the oscilloscope typically has Gaussian frequency response.

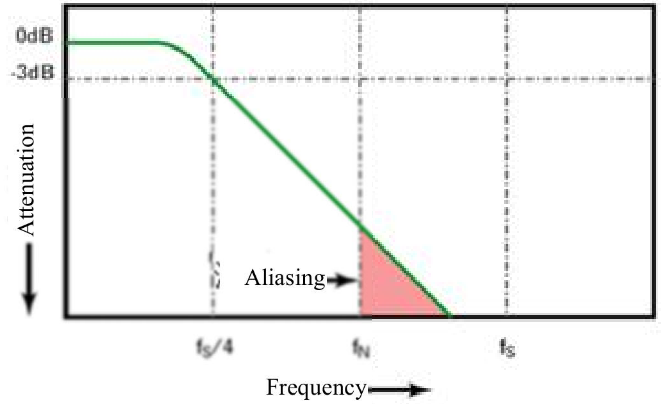


Figure 11-3 Sampling Rate and Oscilloscope Bandwidth

The oscilloscope bandwidth is limited to 1/4 sampling frequency and reduces the frequency response above the Nyquist frequency.

Therefore, in fact, the oscilloscope sampling rate should be 4 times or more of its bandwidth: $f_S \geq 4f_{BW}$. This can reduce aliasing and cause greater attenuation in the aliased frequency components.

Oscilloscope rise time

The oscilloscope rise time is closely related to its bandwidth. The rise time of an oscilloscope with Gaussian type frequency response is approximately $0.35/f_{BW}$ (based on the standard from 10% to 90%).

The oscilloscope rise time is not the fastest edge speed that an oscilloscope can accurately measure. It is the fastest edge speed that the oscilloscope can produce.

Desired oscilloscope bandwidth

The oscilloscope bandwidth required to accurately measure signal is primarily determined by the rise time of the signal rather than the frequency of the signal.

The following steps can be used to calculate the required oscilloscope bandwidth:

1) Determine the fastest edge speed.

    Rise time information is typically obtained from the published device specifications used in the design.

2) Calculate the maximum “actual” frequency component.

According to Dr. Howard W. Johnson's book "*High-Speed Digital Design–A Handbook of Black Magic*", all fast edges have wirelessly continuous frequency components. However, there is a turning point (or "inflection point") in the fast edge spectrum at which frequency components above f_{knee} are negligible in determining the signal shape.

f_{knee}=0.5/signal rise time (based on 10% - 90% threshold)

f_{knee}=0.4/signal rise time (based on 20% - 80% threshold)

3) The multiplication factor for the desired accuracy is used to determine the required oscilloscope bandwidth.

Desired Accuracy	Desired Oscilloscope Bandwidth
20%	$f_{BW}=1.0xf_{knee}$
10%	$f_{BW}=1.3xf_{knee}$
3%	$f_{BW}=1.9xf_{knee}$

Figure 11-4 Bandwidth Corresponding to Oscilloscope Measurement Accuracy

11.2 Run/Stop Key and Single SEQ Key

Use softkeys in the button area to start and stop the oscilloscope acquisition system: Run/Stop button Run Stop and Single Sequence Acquisition SEQ button.

- When the Run/Stop button Run Stop is displayed in green, it indicates that the oscilloscope is running, that is, it meets the trigger condition and data acquisition is being performed. The green "RUN" or "WAIT" is displayed in the upper left corner of the screen.

  To stop data collection, tap the Run/Stop button. After stopping, the screen displays the last acquired waveform.

- When the Run/Stop button Run Stop is displayed in red, it indicates that data acquisition has stopped. The red "STOP" is displayed in the upper left corner of the screen.

  To resume data acquisition, press the Run/Stop button again.

- To capture and display single acquisition (whether the oscilloscope is running or stopped), tap the single sequence key SEQ for a single acquisition.

11.3 Select Sampling Mode

Open the main menu, tap the sampling mode option under “Sampling”, and choose among the four sampling modes: normal, average, peak and envelope in the pop-up box.

The sampling modes of all channels are same. That is, if the sampling mode of any channel is changed, the sampling mode of all channels is changed at the same time.

Normal sampling mode

Oscilloscope samples signal through equivalent time intervals to build waveform. When the time base of 20 ns or faster is chosen, the oscilloscope automatically performs an interpolation algorithm that inserts difference point between sampling points.

This mode produces the best display effects for most waveforms.

Peak sampling mode

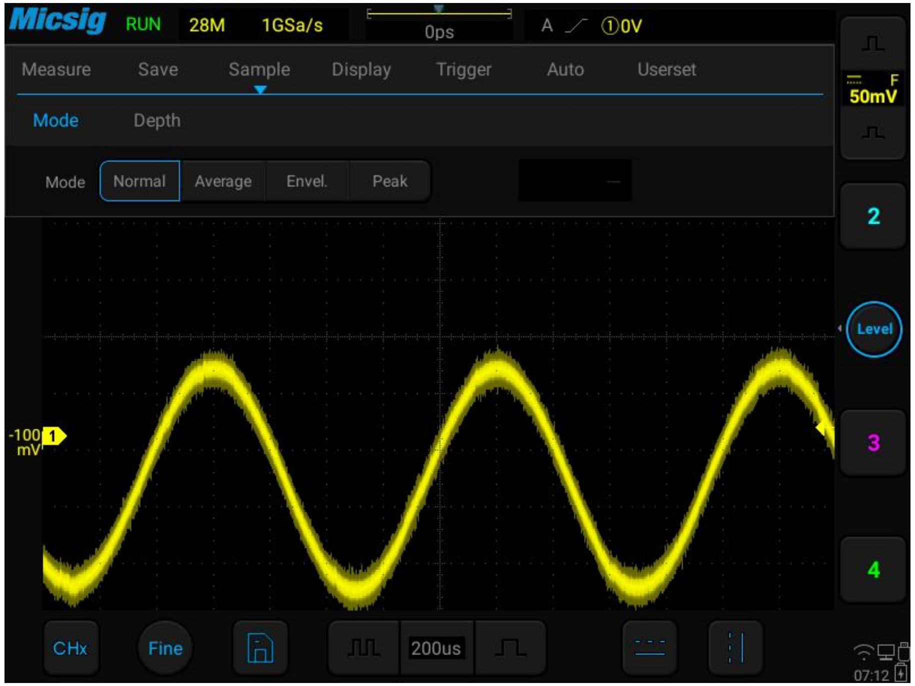
In peak sampling mode, when the horizontal time base setting is low, the minimum and maximum sample values are retained to capture rare events and narrow events (with any noise expanded). This mode will display all pulses that are at least as wide as the sampling period.

When the time base is set to 200ms and above, the oscilloscope will automatically exit the peak sampling mode and switch to the normal sampling mode.

Burr or narrow pulse capture

Burr is the rapid change in waveform that is usually narrower than waveform. Peak sampling mode can be used to view burr or narrow pulses more easily. In the peak sampling mode, narrow burr and transition edges are brighter than in those in the “normal” sampling mode, making them easier to see.

Applying the peak sampling mode can avoid signal aliasing but show more real noises.


Micsig
RUN
28M
1GSa/s
0ps
A
①0V
Measure
Save
Sample
Display
Trigger
Auto
Userset
Mode
Depth
Mode
Normal
Average
Envel.
Peak
50mV
F
2
Level
3
4
-100
mV
1
CHx
Fine
200us
07:12

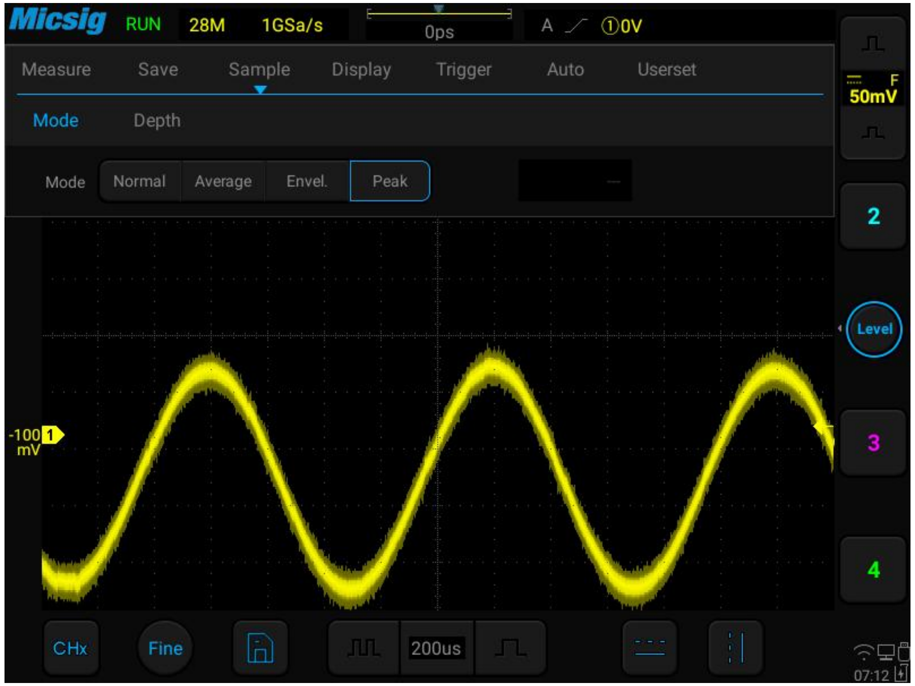


Figure 11-5 Sine Wave with Burr Normal Sampling Mode

Figure 11-6 Sine Wave with Burr Peak Sampling Mode

Use peak detection mode to find burrs

1) Connect signal to the oscilloscope to be stably displayed.

2) To find burr, select the peak sampling mode in Sampling Mode option in the Channel menu.

3) In the menu, tap “Display” → “Persistence”, then tap “∞” (infinite persistence). The oscilloscope will restart sampling data and display them on the screen.

4) Use the zoom mode to represent the characteristics of burr:

   a. Tap the “Zoom” button in the main menu to open the zoom window.

   b. To get a better resolution of burr, expand the time base to set the expanded portion of the normal window view around burr.

Average sampling mode

The average sampling mode averages multiple acquisition results to reduce random or unrelated noises in the displayed signal. The average of multiple sampling results requires stable trigger.

The average number can be set in the selection box after the average sampling mode, and can be set to eight order of magnitudes: 2, 4, 8, 16, 32, 64, 128 and 256.

The higher the average number is, the slower the response of the displayed waveform-to-waveform changes. A compromise must be made between the response speed of waveform versus the changes and the degree of noise reduction shown on the signal.

Use average sampling mode

1) Open the channel menu and select the average sampling mode in the sampling mode option.
2) Press the number box on the right of the average sampling mode box to pop up the average number and then tap it to set the average number that can best eliminate displayed waveform noises.



Figure 11-7 Waveform after choosing the average sampling mode, with average number 32

Envelope sampling mode

In the envelope sampling mode, the superposition effect of several sampled waveforms can be observed. The maximum and minimum values of one signal can be captured in the specified N sample data, and the number of waveform superpositions can be set to 2, 4 , 8, 16, 32, 64, 128, 256 or ∞.



Figure 11-8 AM Signal in Envelope Sampling Mode (32)

11.4 Record Length and Sampling Rate

The record length is the data volume for each captured waveform. For example, if the record length is 700K, it means that 700K sample points are captured by one trigger.

In the main menu, tap "Sample" to enter the record length setting menu, which can be set by tapping the corresponding record length.

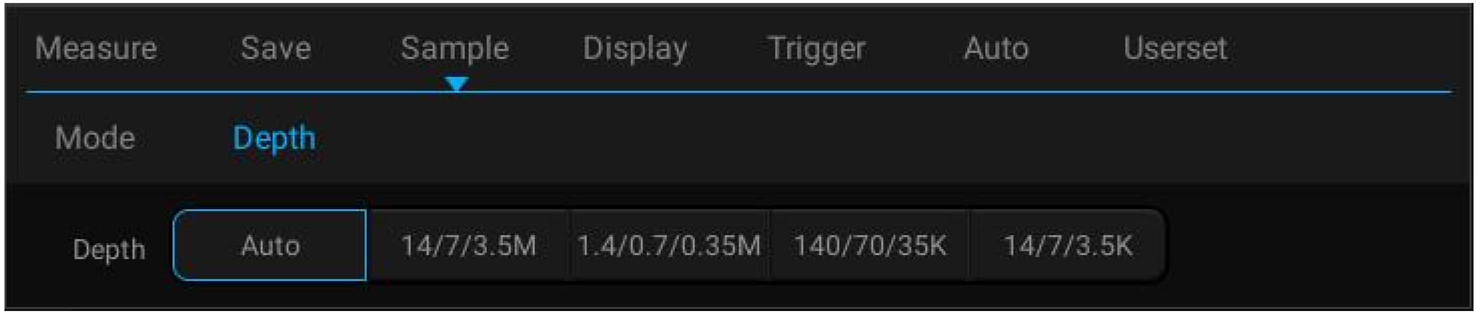


Figure 11-9 Record Length

In normal refresh mode, if it is a single channel, the record length can be set to 14k, 140k, 1.4M, 14M, 28M, Auto; if it is dual channel, the record length can be set to 7k, 70k, 0.7M, 7M, 14M, Auto; if it is three or four channels, the record length can be set to 3.5k, 35k, 0.35M, 3.5M, 7M, Auto.

Record length and sampling rate

The record length is data volume collected per waveform capture. For example, if the record length is 0.7M, it means that 700K sample points are captured by one trigger.

The oscilloscope record length and sampling rate have the following relationship:

Sampling rate = record length/acquisition time

Generally, the oscilloscope acquisition time is exactly the display time on the current entire screen (current horizontal time base×14).

For example, if the oscilloscope has the memory depth of 700K, the sampling rate of 1GSa/s, and the horizontal time base of 50us/div, the acquisition time is 700us, which is 50us/div×14div.

However, when the fast time base (below 20 ns) or the record length is set to a fixed value, the oscilloscope acquisition time does not necessarily represent the display time on the current entire screen.

For example, if the oscilloscope has the memory depth of 700K, the sampling rate of 1GSa/s, and the horizontal time base of 20ns, the acquisition time is 700ns, which is 2.5 times of the current display time on the entire screen.

Or, if the memory depth is 140K (fixed value), the sampling rate is 1GSa/s, and the horizontal time base is 1us, the acquisition time is 140us, which is 10 times of the current display time on the entire screen.

For a single channel in a channel pair, the maximum sampling rate of the Smart Series oscilloscope is 1GSa/s.

If any two channels are opened, the sampling rate of the two channels will halved. For example, when CH1 and CH3 are opened, the sampling rates of CH1 and CH3 are both 500 MSa/s.

If any three channels or all four channels are opened, the sampling rate per channel will become 1/4 of the maximum sampling rate. For example, when CH1, CH2 and CH3 are opened, the sampling rates of CH1, CH2 and CH3 are 250 MSa/s for each of them.

Chapter 12 Serial Bus Trigger and Decode (Optional)

This chapter contains the detailed information of serial bus decoding. You are recommended to read this chapter carefully to understand the setting and operation of Smart bus trigger and decode.

This chapter mainly include the below contents:

- UART (RS232/RS422/RS485) bus trigger and decode
- LIN bus trigger and decode
- CAN bus trigger and decode
- SPI bus trigger and decode
- I2C bus trigger and decode
- ARINC429 bus trigger and decode
- 1553B bus trigger and decode

Swipe up or down at the channel selection area to enter the second channel selection area, tap 

or 

to enable decoding, open bus configuration menu, select bus type, there are seven bus types: UART (RS232/RS422/RS485), LIN, CAN, SPI, I2C, ARINC429, 1553B, where channels S1 and S2 can be used for decoding simultaneously. Open the trigger setting menu, choose an appropriate trigger type, the corresponding bus trigger type and trigger mode can be set when the bus trigger is selected, and the serial bus is displayed in graphic form.

In the serial bus decode mode, if it is screen rolling in other modes, the time base is automatically adjusted to 1ms when switching to serial decode (the maximum time base supported by the serial decode mode is 100ms); in Zoom mode, the enlarged signal can be decoded and displayed. The normal display window supports a maximum time base of 100ms. When decoding is enabled, clicking “AUTO” will set the trigger type to be the same as the decode channel bus type. The bus type selection menu is shown in Figure 12-1:



Figure 12-1 Bus Type Selection Menu

Open the pull-up menu and tap  key to open or close the text mode, as shown in Figure 12-2.

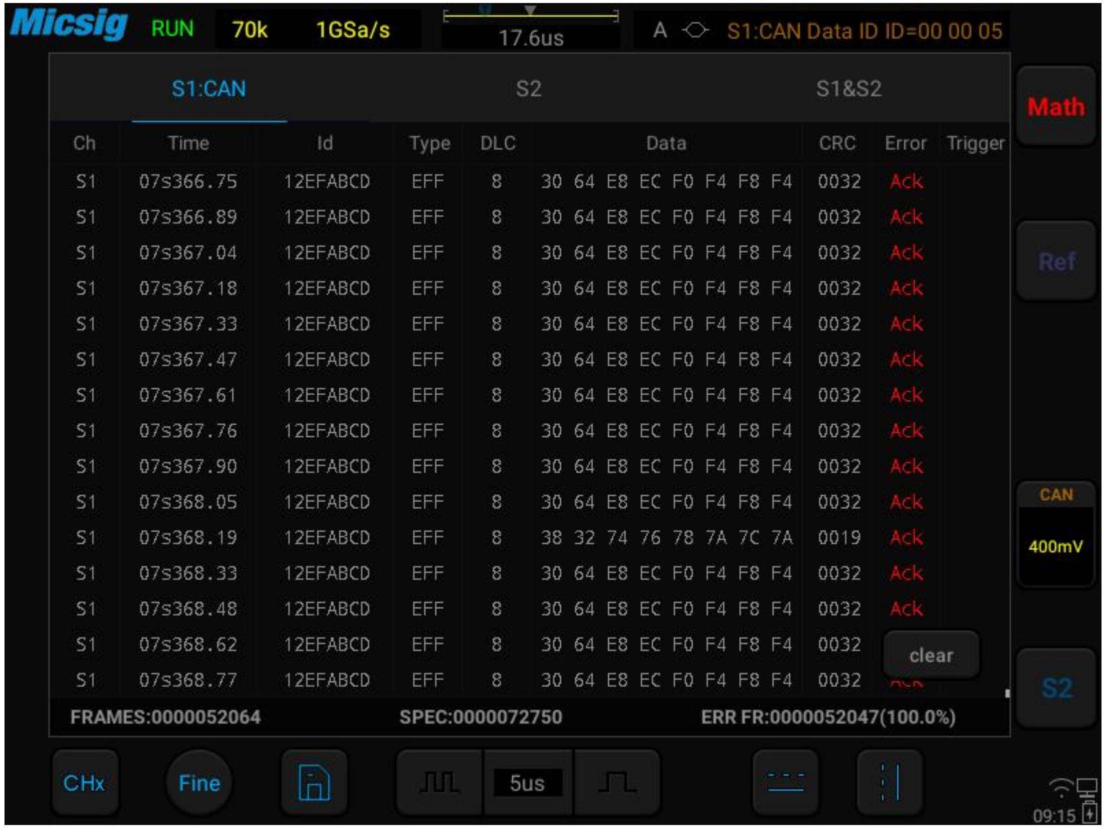


Figure 12-2 Bus Decode Text Mode

Description:

Two decode channels S1&S2 in the text interface must be configured identically to be opened, and each channel is displayed in chronological order with different colors;

S1/S2/S1&S2 are the channel configuration bus information, and X knob is rotated or the label is switched to change the bus channel;

Clicking save during the text acquisition process can save all currently acquired data. If the date volume is too large, “wait” will be displayed, and the save success prompt will be displayed.

Oscilloscope can be used as a USB storage device to view saved files on a computer, as shown in Figure 12-3:

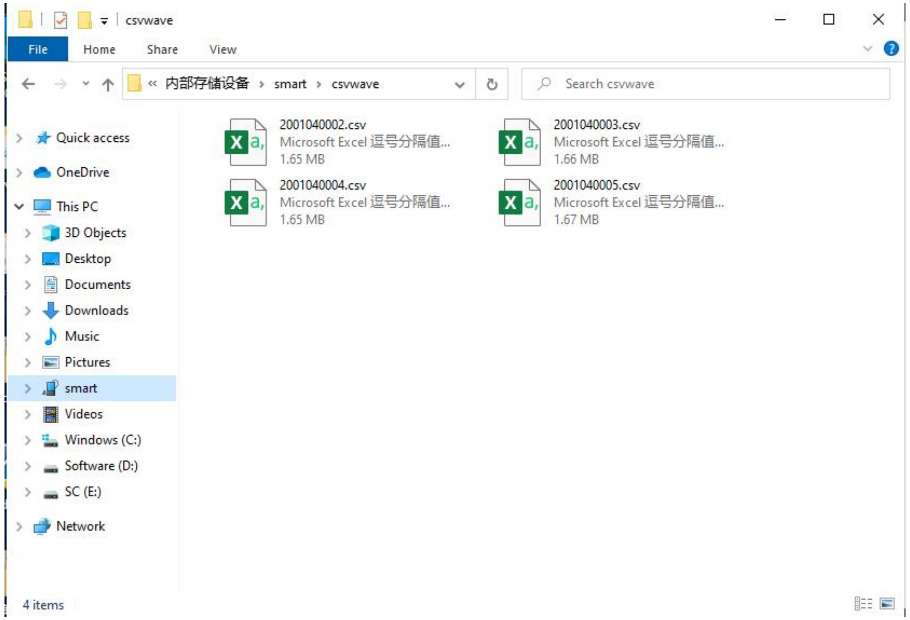


Figure 12-3 Bus Text Storage Files

12.1 UART (RS232/RS422/RS485) Bus Trigger and Decode

For correctly decoding UART(RS232/RS422/RS485) bus data and making trigger stable, the bus configuration, trigger mode setting and trigger level need to be adjusted.

- **Bus configuration**

Left swipe 

or 

to open the bus configuration menu, as shown in Figure 12-4. The RX channel must be chosen and the following parameters must be set according to measured signals:

Idle Level — Choose Idle Low or Idle High to match the idle state of measured equipment. For RS232, Idle Low may be chosen.

Note: RS232 industry standard uses "negative logic", namely high level is logic "0" and low level is logic "1".

Parity Bit — Choose odd, even or none depending on measured equipment.

Word Length — Set the number of bits in UART word to match measured equipment (5-9 bits available).

Baud Rate — Choose the baud rate that matches signal in measured equipment.

The baud rate can be set within the range from 1.2Kb/S to 8.000Mb/S.

Bus Display — Choose hexadecimal, binary or ASCII code display.



Figure 12-4 UART Bus Configuration Menu

When word is displayed in ASCII, 7-bit ASCII format is used. Valid ASCII characters are between 0x00 and 0x7F. To display in ASCII, at least 7 bits in the “Bus Configuration” must be chosen. If ASCII is chosen and the data exceeds 0x7F, the data will be displayed in hexadecimal.

Click the baud rate setting box to open the baud rate selection column. If Custom is chosen, click to pop up the virtual soft keyboard, select the bit to be modified, enter value, and click “Enter” on the virtual soft keyboard to complete setting. The baud rate can be set from 1.2Kb/S to 8.000Mb/S. The virtual soft keyboard is shown in Figure 12-5:



Figure 12-5 Baud Rate Default Setting

Note: When there is parity bit, the data word length indicates the total length of data bit plus parity bit. When there is no parity bit, the data word length is considered to be the length of data bit. For example, if the data word length is 8bit, when there is no parity bit, it means that the total length of data bits is 8bit; when there is parity bit, it means that the total length of data bits is 7bit, and there is parity bit of 1 bit.

- **Trigger mode**

Open the trigger configuration menu and select the appropriate trigger type; when choosing UART bus trigger, the trigger type, trigger relationship and trigger data need to be set, as shown in Figure 12-6:

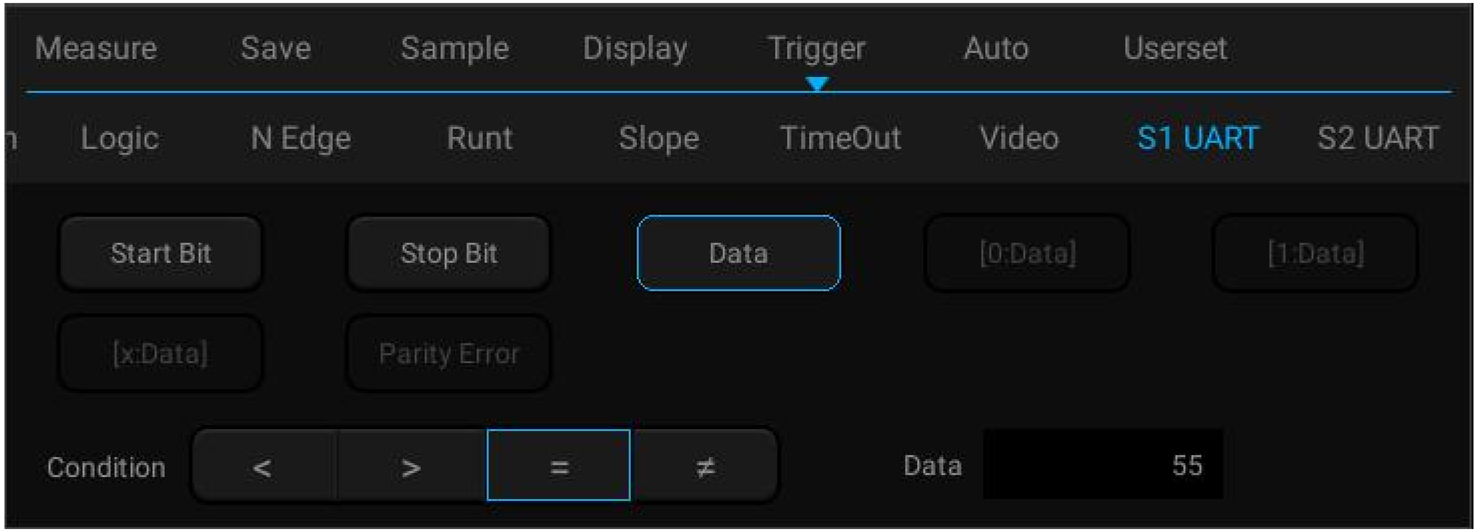


Figure 12-6 Trigger Setting Menu

After selecting the trigger data, use the pop-up virtual keyboard to modify it, enter the value, and click "Enter" on the virtual soft keyboard to complete the setting.

UART trigger configuration menu description:

a) Start bit — trigger at the start bit of the measured signal;

b) Stop bit — trigger at the stop bit of the measured signal, no matter the measured signal uses 1, 1.5, or 2 stop bits or not, the trigger will occur at the first stop bit.

c) [data] — Trigger at the specified data bit, when measured signal data bits are effective as 5 to 8bits, select [data], and select the trigger relationship as” =“ “ >“ “ <“ “≠”, then select “Trigger Data”, press data on the touch screen, and use the pop-up virtual keyboard to modify;

d) [0:data] — the measured signal data bits is 9bits (the 9th bit is parity bit). Only when the 9th bit is 0, then trigger. The trigger relationship, trigger data configuration are the same as those of [data] trigger;

e) [1:data] — the measured signal data bits is 9bits (the 9th bit is parity bit). Only when the 9th bit is 1, then trigger. The trigger relationship, trigger data configuration are the same as those of [data] trigger;

f) [x:data] — the measured signal data bits is 9bits (the 9th bit is parity bit). No matter what the value of the 9th bit is, trigger at the designated data bit. The trigger relationship, trigger data configuration are the same as those of [data] trigger;

g) Parity error — valid when there is parity check at parity bit, trigger while parity error.

- **UART serial decode**

The measured signal word length is 8bit; parity bit, none; baud rate, 19.2kb/s, hexadecimal; trigger mode as data bit:55; follow the steps as below:

(1) Tap S1 to open the decode channel, and click S1 again to open the bus configuration menu;

(2) Select the bus type as “UART”, click “Ch1”, “Idle High”, “Parity None”, “8bit”, “19.20kb/s”, display “hexadecimal”, then close menu;

(3) Open the trigger mode setting menu, click “Data”, enter 55 manually, and press “enter” to confirm;

(4) Adjusting the threshold level according to the amplitude level of signal may make the signal to be stably triggered. The UART trigger graphic interface is shown in Figure 12-8:

Method 1: Click 

configuration information to open the decode channel threshold level adjustment box, and drag the adjustment box upward and downward to adjust the threshold level.

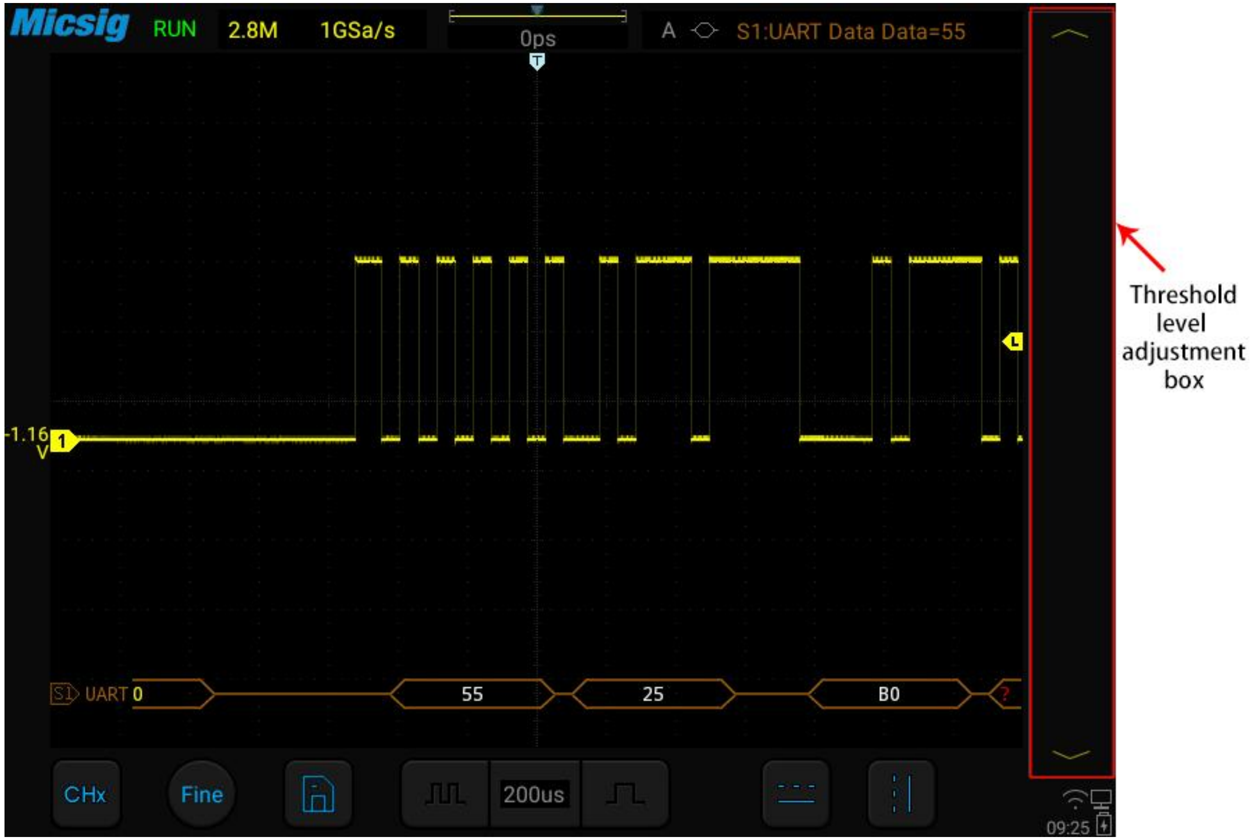
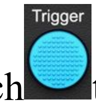


Figure 12-7 UART Decode Level Adjustment

Method 2: Long press trigger navigation switch 

to switch between bus threshold level and trigger level.

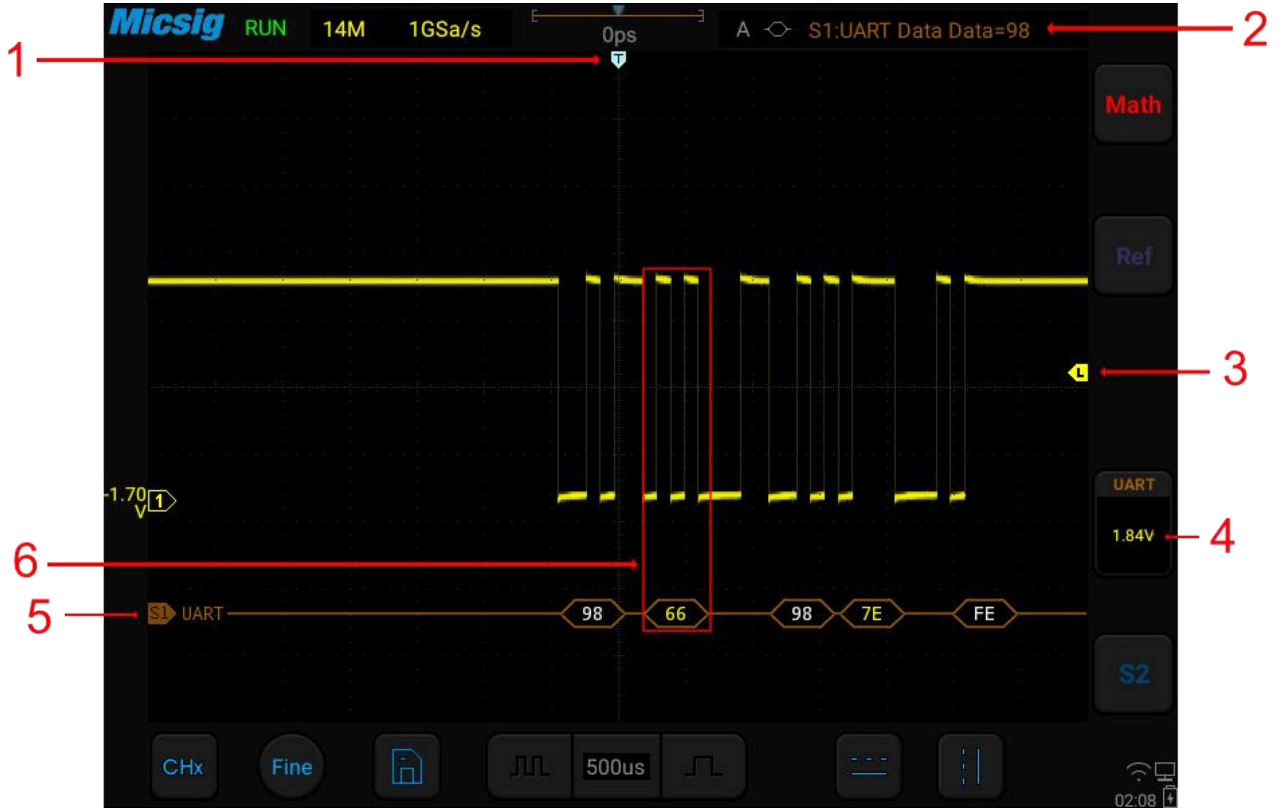


Figure 12-8 UART Graphic Interface

UART graphic interface description:

(1) Trigger position

(2) Trigger type

(3) Threshold level

(4) Configuration information

(5) Decode the data packet, detailed as follows

(6) Decode data and the corresponding waveform area

UART decode data packet description:

(1) Decode data packet displays real-time data about the bus activities;

(2) Decode data displays as hexadecimal system in white;

(3) When the word length is 5-8 bits, the decode data displays as two bits of hexadecimal; when the word length is 9 bits, the decode data displays as 3 bits of hexadecimal, and the 9th bit displays at the left side;

(4) When there is error in decode data, if the error is at stop bit, the data displays in yellow, if it is parity error, data displays in red;

(5) When “?” appears, the time base needs to be adjusted to view decode results.

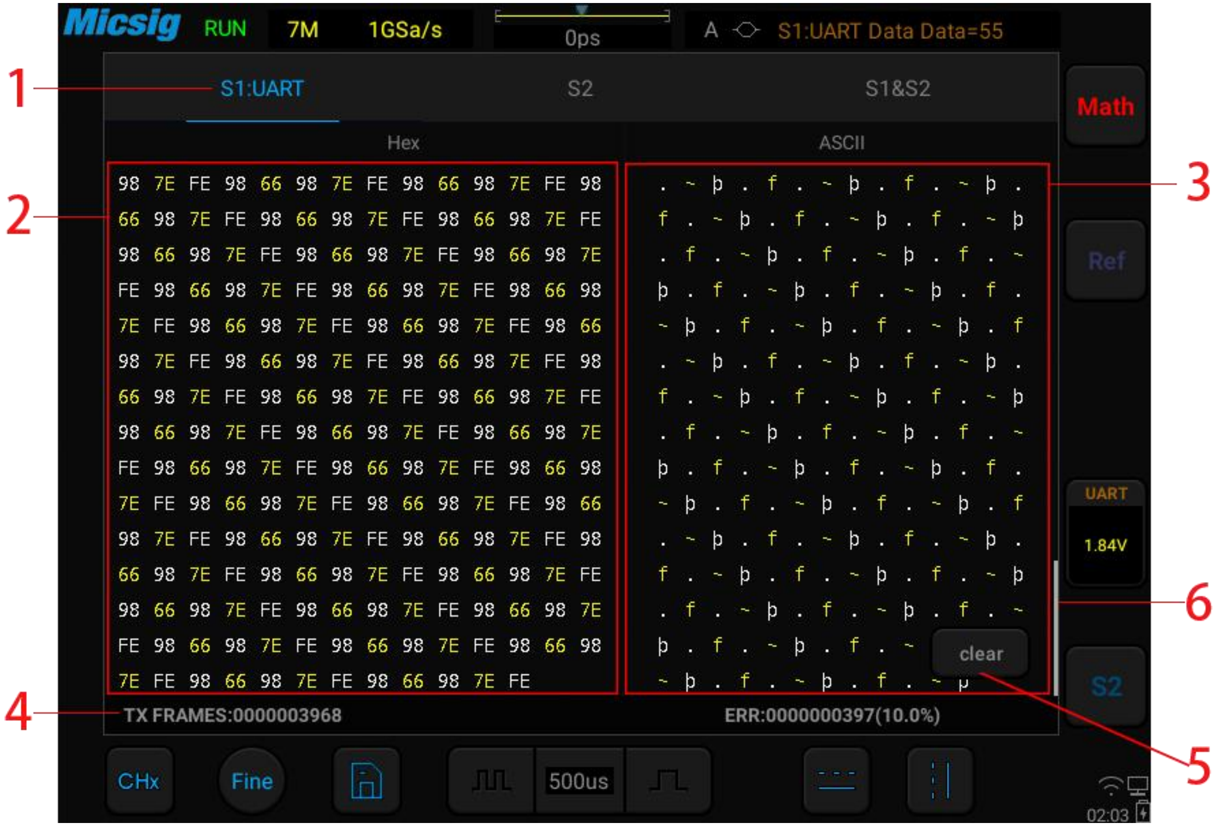


Figure 12-9 UART Text Interface

UART text interface description, see Figure12-9:

(1) S1/S2/S1&S2 is channel configuration bus information.

(2) Area for decode data.

(3) ASCII code corresponding to the text data (when the data format is 9 bits and there is no parity bit, ASCII code corresponds to lower 8 bits of data on the left side).

(4) Counter: Calculates the total number of frames and the percentage of ERR (parity error and stop bit error) frames.

(5) Clear: Clear the counter data.

(6) Roller bar.

In the decode data area, the stop bit error data is displayed in yellow, and the decode error data is displayed in red;

12.2 LIN Bus Trigger and Decode

For correctly decoding LIN bus data and making trigger stable, the bus configuration, trigger mode set and trigger level need to be adjusted.

- **Bus configuration**

Left swipe 

or 

to open the bus configuration menu, and the following need to be set according to measured signal:

Source — Select the signal source of decode.

Idle Level - high and low. Select whether to display high active or low active after the signal start bit of measured equipment.

Baud Rate — Select the baud rate that matches the signal being measured, and it can be customized.

The setting method is the same as that of UART, and will not be repeated here. As shown in Figure 12-10:



Figure 12-10 LIN Bus Configuration Menu

- **Trigger mode**

Open the trigger configuration menu and select the appropriate trigger type. When the LIN bus trigger is selected, the trigger mode includes: synchronous rising edge, frame ID, frame ID and data. See Figure 12-11:

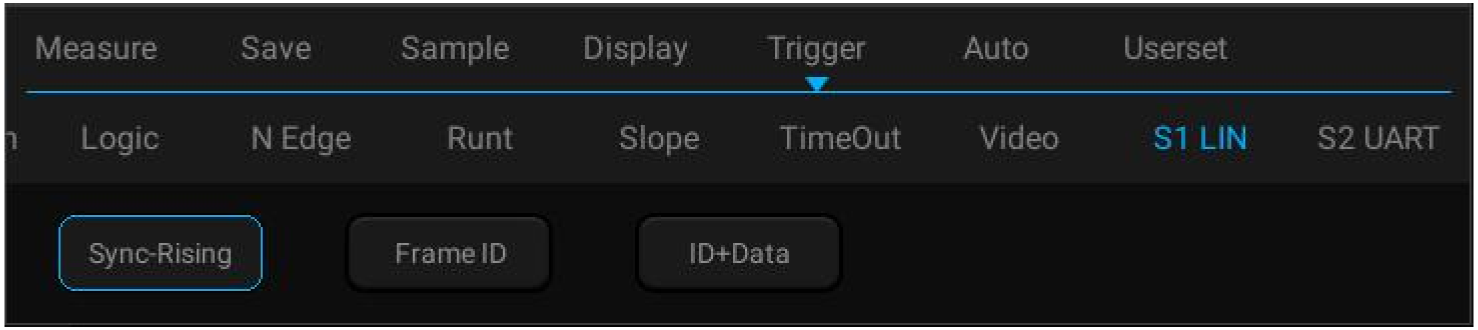


Figure 12-11 LIN Trigger Mode Configuration Menu

a) Synchronous rising edge – When the "Sync Interval" of LIN bus ends, the rising edge triggers.

b) Frame ID — Triggered when a frame with an ID equal to the set value is detected. Select "Frame ID", click data on the touch screen, and use the pop-up virtual keyboard to modify it.

c) Frame ID and data—triggered when a frame with ID and data equal to the set value is detected. After selecting "Frame ID and Data", click ID or data, and set them.

- **LIN serial decode**

Ch1 is connected to measured signal. The idle level is high and the baud rate is 19.2 kb/s. The trigger mode is synchronous rising edge. Please follow these steps:

(1) Tap S1 to open the decode channel, and click again to open the bus configuration menu;

(2) Select the bus type as “LIN”, click “Ch1”, “Idle High”, “19.20kb/s”, and then close the menu;

(3) Open the trigger mode configuration menu and click “Synchronous Rising Edge”;

(4) Click 

configuration information to open the decode channel threshold level adjustment box, and drag the adjustment box upward and downward to adjust the threshold level; adjust the threshold level according to the signal amplitude level to make the signal stably triggered. The LIN trigger graphic interface is shown in Figure 12-12:

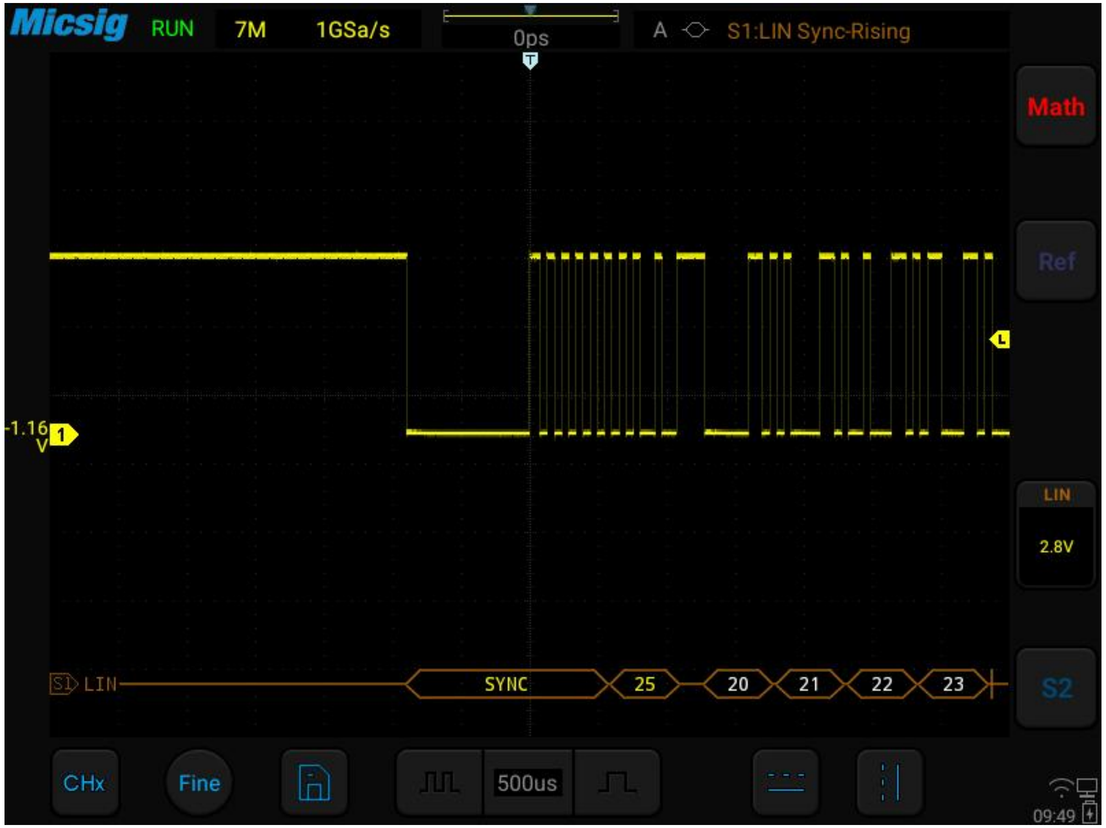


Figure 12-12 LIN Graphic Interface

LIN decode data packet description:

(1) Decode data packet displays real-time data about the bus activities.

(2) Decode data displays as hexadecimal system.

(3) “Frame ID” displays in yellow, “Data” displays in white, and “Parity sum” displays in green. If the parity sum has error, it is displayed in red “E”.

(4) When “?” appears, the time base needs to be adjusted to view decode results.

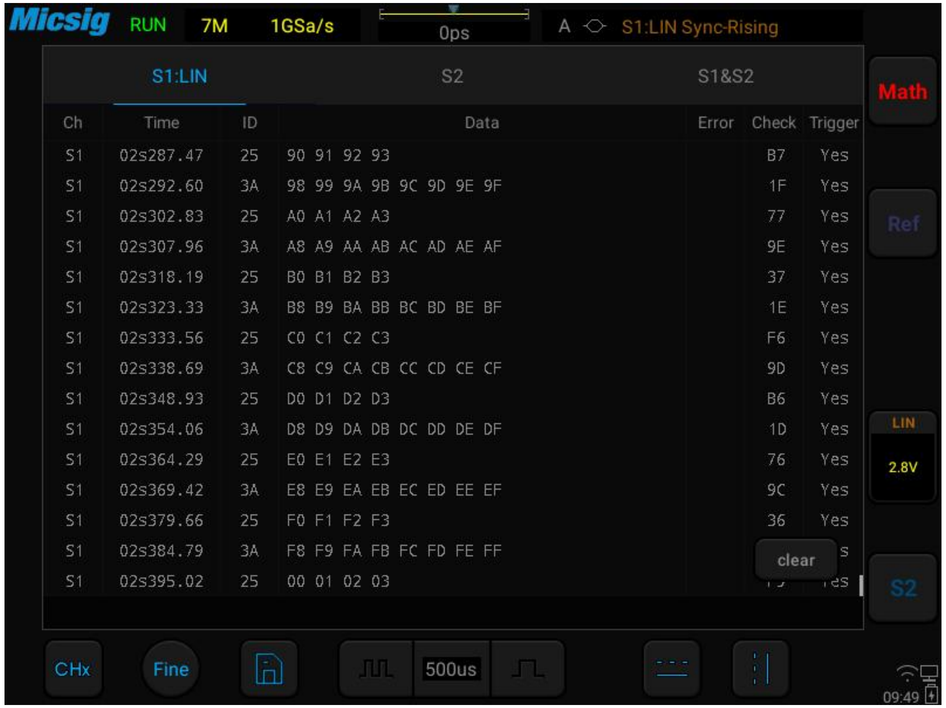


Figure 12-13 LIN Text Interface

LIN text interface description, as shown in Figure 12-13:

(1) “Ch”: bus channel.

(2) “Time”: Time intervals between the last frames to current frames.

(3) “ID”: Frame ID value.

(4) “Data”: Frame data.

(5) “Parity sum”: Frame parity sum, the sum of parity error displays in red.

(6) “Trigger”: “Yes” means the frame reaches trigger condition.

(7) “Clear”: Clear counter data.

12.3 CAN Bus Trigger and Decode

For correctly decoding CAN bus data and making trigger stable, the bus configuration, trigger mode set and trigger level need to be adjusted.

- **Bus configuration**

  Left swipe S1 or S2 to open the bus configuration menu, the signal source needs to be set, and the signal type and baud rate are set according to measured signal; the setting method is the same as that of UART and will not be repeated here. See Figure 12-14:



Figure 12-14 CAN Bus Configuration Menu

- **Trigger mode**

Open the trigger configuration menu and select the appropriate trigger type; when S1 CAN bus trigger is selected, as shown in Figure 12-15:

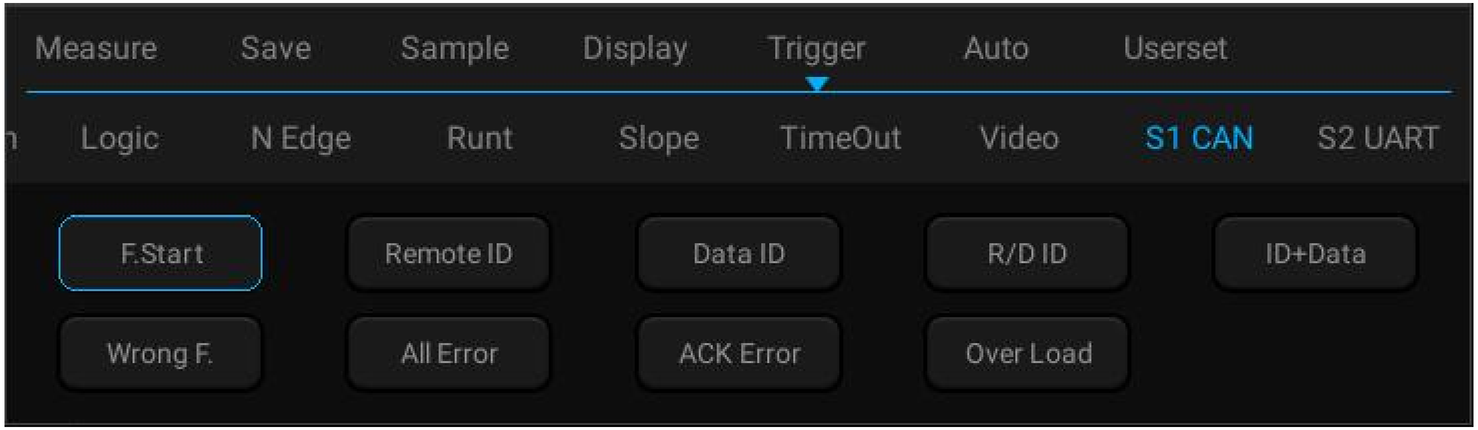


Figure 12-15 CAN Trigger Mode Configuration Menu

Trigger mode selection menu description:

a) Frame start — trigger at the start of the frame;

b) Remote frame ID — setting the ID matches the remote frame trigger. After selecting the "Remote Frame ID", and then set the ID value at the bottom of the trigger data area

Operation description: Press the numbers on the touch screen and use the virtual keyboard to set;

c) Data framed ID — trigger on data frame that matches set ID. Data frame ID configuration mode is the same as the remote data frame ID configuration;

d) Remote frame/data frame ID — trigger on remote frame or data frame that matches set ID. Remote frame/data frame ID configuration is the same as the remote data frame ID configuration;

e) Data frame ID and data ID — trigger on data frame that matches set ID and data. The configuration method is the same as the remote frame ID configuration;

f) Error frame — trigger on CAN error frame;

g) All errors — trigger when there is any error in format or activity;

h) Ack error — trigger on recessive (high) Ack position;

i) Overload frame — trigger on CAN overload frame.

- **CAN serial decode**

Ch1 is connected to measured signal. The idle level is high and the baud rate is 1Mb/s; the Trigger mode is the frame start. Please follow these steps:

(1) Tap S1 to open the decode channel, and click S1 again to open the bus configuration menu;

(2) Select the bus type as "CAN", and then click "Ch1", "Idle High" and "1Mb/s". After setting, click the blank area to close the menu;

(3) Open the trigger mode configuration menu and click "Frame Start";

(4) Adjust the threshold level according to the signal amplitude; the CAN trigger graphic interface is shown in Figure 12-16:

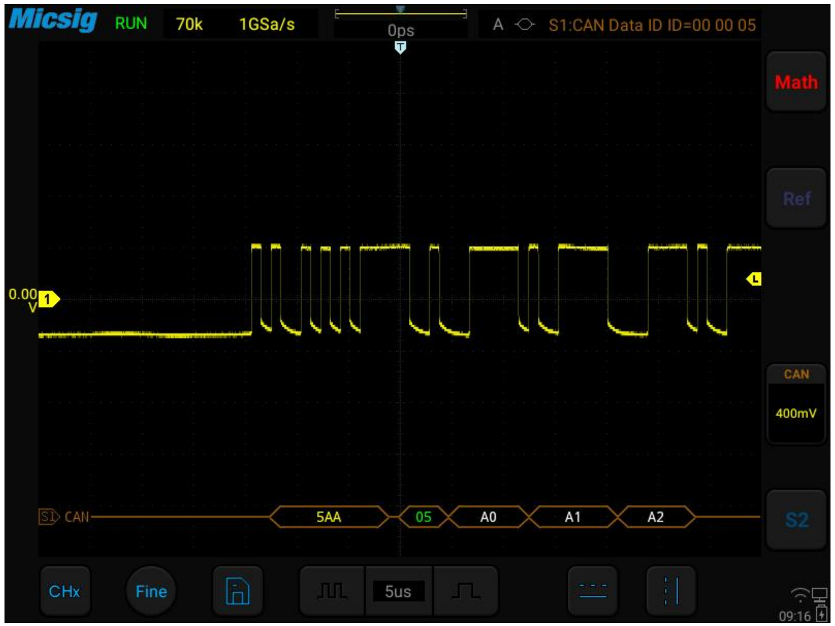


Figure 12-16 CAN Graphic Interface

CAN decode data packet description:

(1) Decode data packet displays real-time data about the bus activities.

(2) Decode data displays as hexadecimal system.

(3) “Frame ID” displays in yellow, “Data” displays in white, and “DLC” and “ CRC” codes display in green. If there is frame error, it is displayed in red “E”.

(4) When “?” appears, the time base needs to be adjusted to view decode results, and “!” indicates that the bus waveform corresponding to the decode data packet is incomplete and the data cannot be displayed correctly.

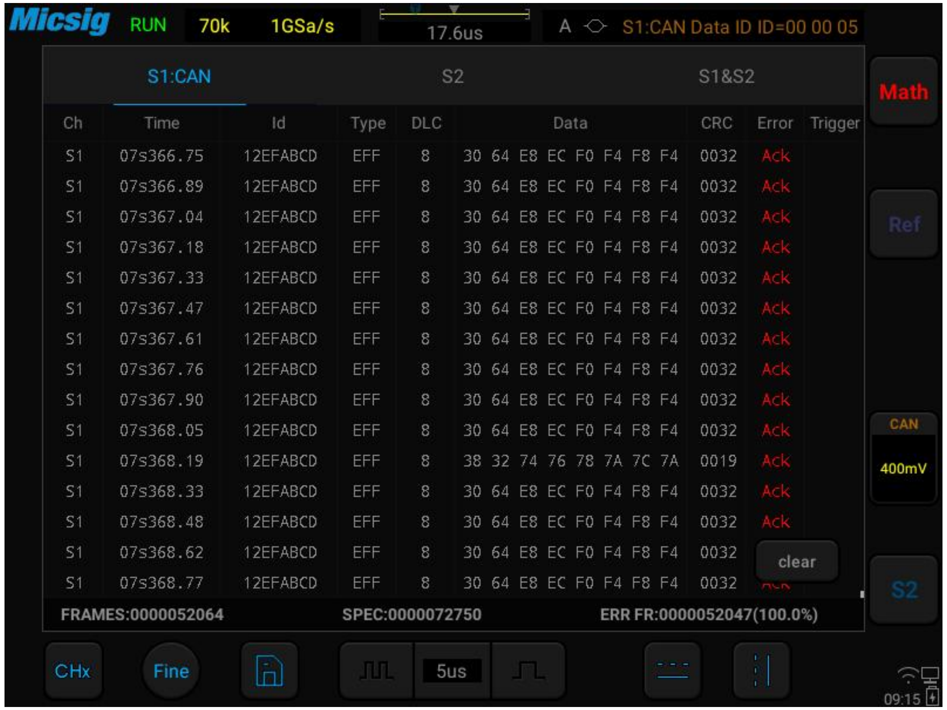


Figure 12-17 CAN Text Interface

CAN text interface description, as shown in Figure 12-17:

(1) “Ch”: bus channel.

(2) “Time”: Time intervals between the last frames to current frames.

(3) “ID”: CAN frame ID value displayed in hexadecimal, maximum 29 bits.

(4) "Type": Frame type, "SFF" standard data frame, "SRF" standard remote frame, "EFF" extended data frame, "ERF" extended remote frame.

(5) "DLC": Number of data bytes sent by this frame. This value can be ignored for remote frames.

(6) "Data": Frame data.

(7) "CRC": Frame CRC check code.

(8) "Error": Response error, bit stuffing error, format error, CRC error.

(9) "Trigger": "Yes" means the frame reaches trigger condition.

(10) "Statistics": counts the number of occurrences of frame type, data length, status, etc., and the percentage.

12.4 SPI Bus Trigger and Decode

For correctly decoding SPI bus data and making trigger stable, the bus configuration, trigger mode set and trigger level need to be adjusted.

- **Bus configuration**

Left swipe 

or 

to open the bus configuration menu, the following need to be set:

Clock source, data source, chip select signal, and data word length, as shown in Figure 12-18:

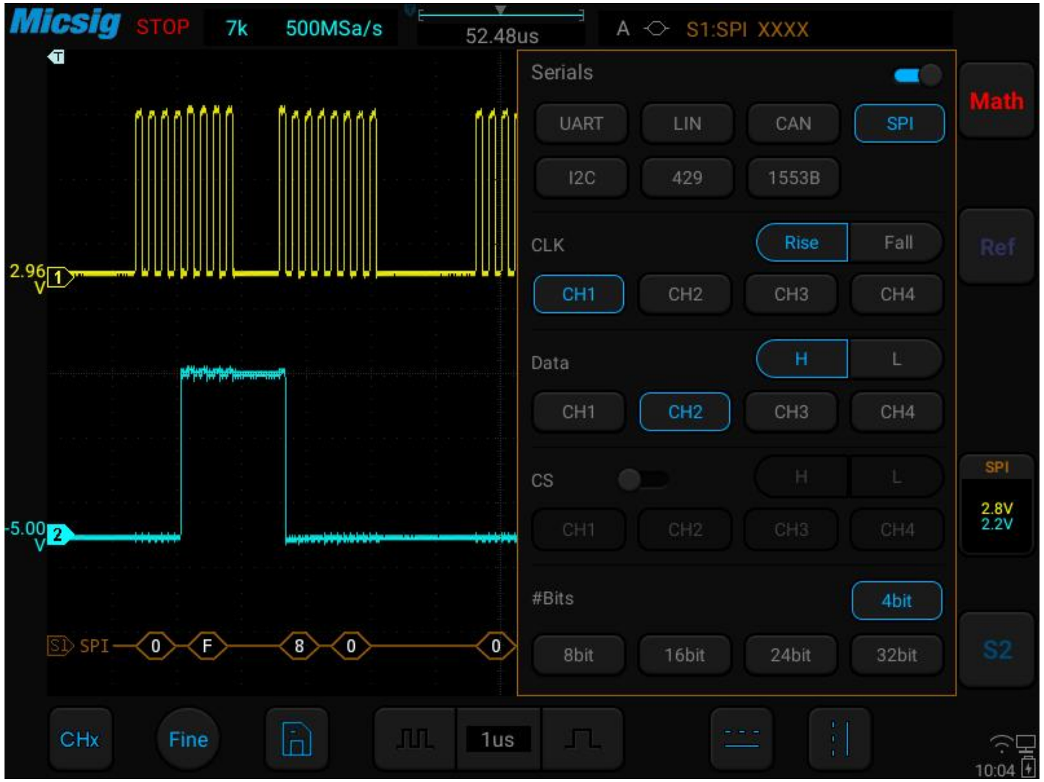


Figure 12-18 SPI Bus Configuration Menu

- **Trigger mode**

Open the trigger configuration menu and select the appropriate trigger type; when selecting the SPI bus trigger, as shown in Figure 12-19:



Figure 12-19 SPI Trigger Mode Configuration Menu

The operation method is the same as CAN frame ID to be matched in the configuration, and will not be repeated here.

Note: According to the data byte length set by bus decode, the value of the relevant bit within the byte length is set. Trigger when the corresponding bit on data bus matches the set value.

- **SPI serial bus**

The measured signal channel Ch1 is connected to CLK, Ch2 channel is connected to DATA, the bus idle state is high, the clock rising edge is sampled; the data word length is 4 bits; the CS chip select is off; the trigger mode matches the "Data" at 0001, please follow the steps below:

(1) Tap S1 to open the decode channel, and click S1 again to open the bus configuration menu;

(2) Select the bus type as "SPI", click clock as "Ch1" rising edge, the data is "Ch2" high level, and the data word length is "4bit";

(3) Open the trigger setting menu, click data on the touch screen, and use the virtual soft keyboard to set the data to be matched as "0001";

(4) Adjust the threshold levels of two channels according to signal amplitude; the SPI trigger graphic interface is shown in Figure 12-20:

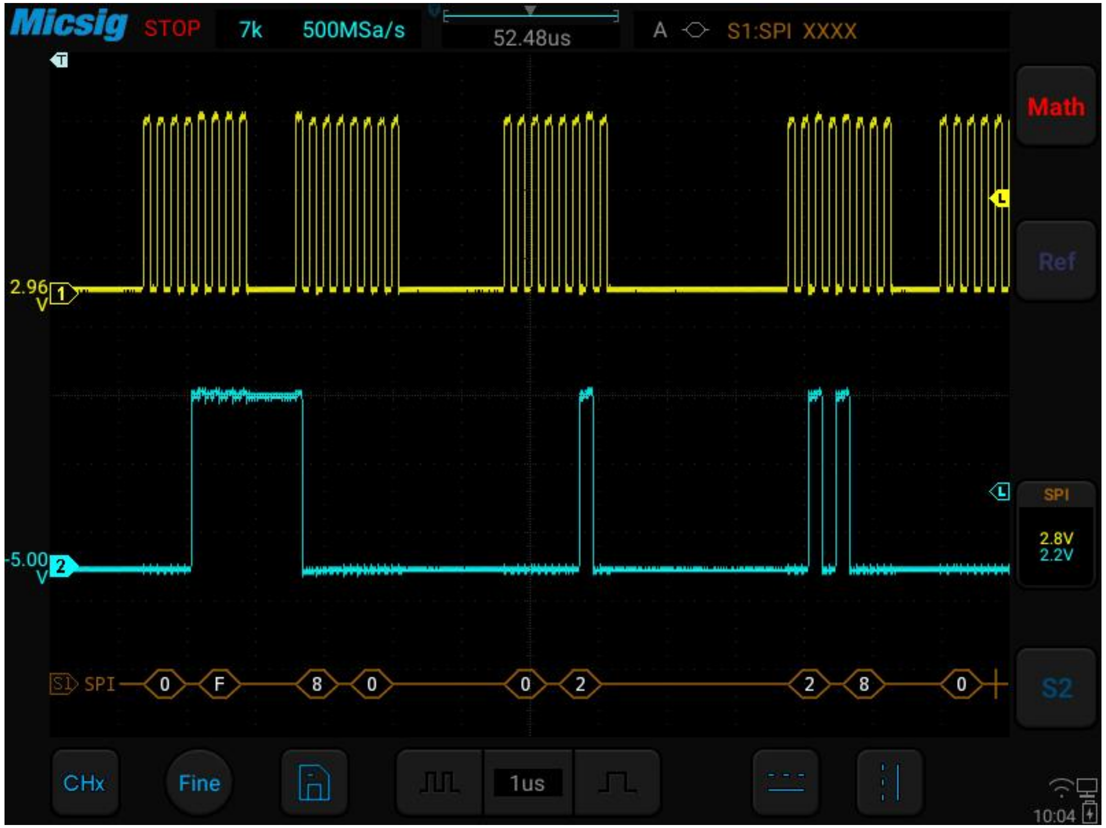


Figure 12-20 SPI Graphic Interface

SPI decode data packet description:

(1) Decode data packet displays real-time data about the bus activities.

(2) Decode data displays as hexadecimal system.

(3) Data displays in white.

(4) When “?” appears, the time base needs to be adjusted to view decode results.

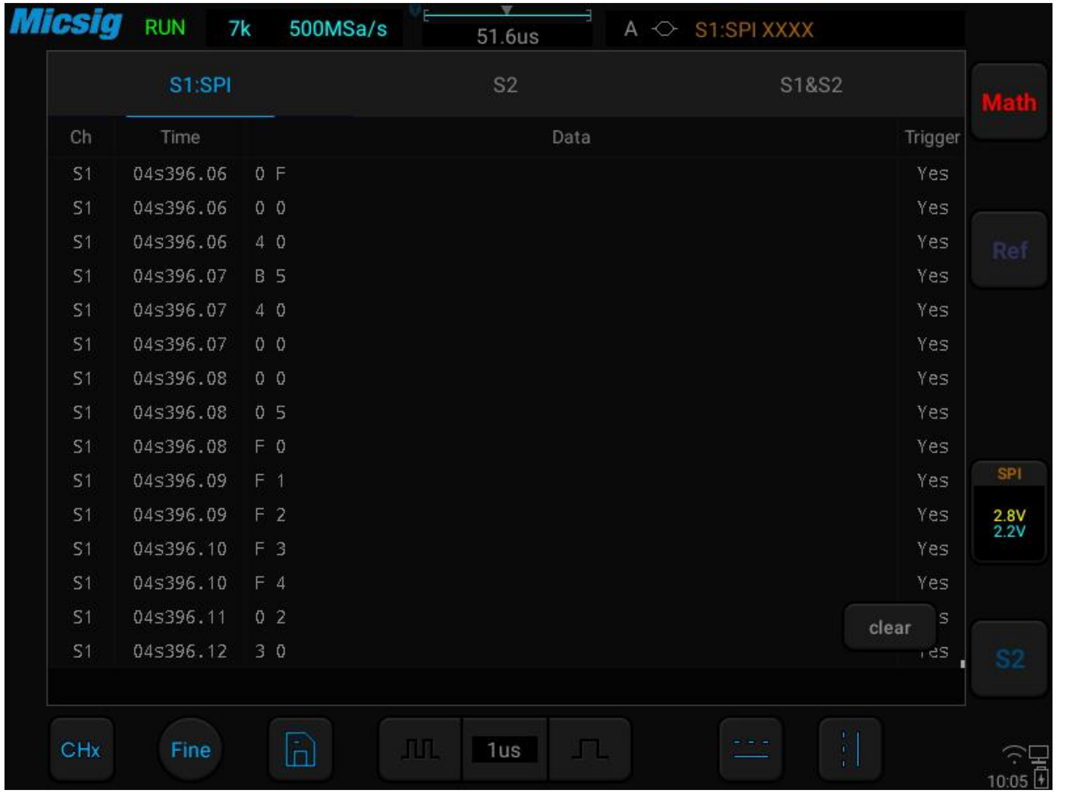


Figure 12-21 SPI Text Interface

SPI text interface description, as shown in Figure 12-21:

(1) "Ch": bus channel.

(2) "Time": Time intervals between the last frames to current frames.

(3) "Data": According to the data word length setting, the decode data is displayed. For example, if the data word length is 8bit, only one byte displays in the data column; if the data word length is 16bit, 2 bytes display in the data column; if the data word length is 24bit, 3 bytes display; and if the data word length is 32bit, 4 bytes display.

(4) "Trigger": "Yes" means the frame reaches trigger condition.

Note: "One frame" is measured by the set "data word length" and can meet 1 data bit code stream.

12.5 I2C Bus Trigger and Decode

For correctly decoding I2C bus data and making trigger stable, the bus configuration, trigger mode set and trigger level need to be adjusted.

- **Bus configuration**

  Left swipe 

 or 

 to open the bus configuration menu, Bus configuration includes the serial clock (SCL) and the serial data (SDA) corresponding to the channel settings. See Figure 12-22:

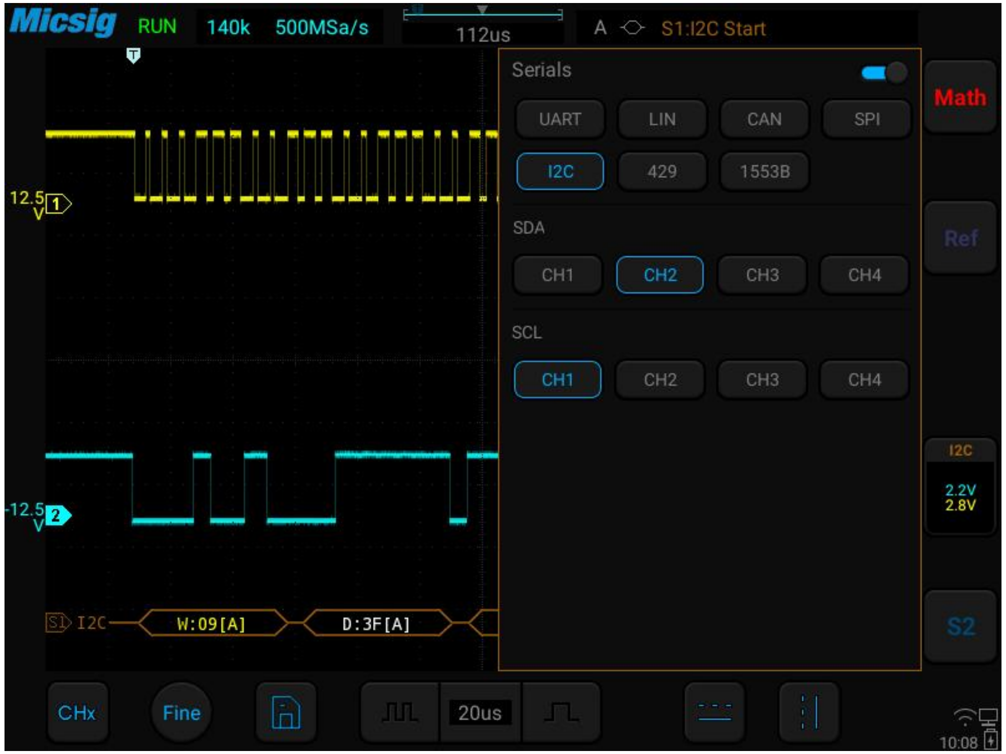


Figure 12-22 I2C Bus Configuration Menu

Notes: When SCL or SDA channel is set, the system will automatically set other channels.

- **Trigger mode**

Open the trigger configuration menu and select the appropriate trigger type. When the I2C bus trigger is selected, click the trigger type and relationship on the screen, as shown in Figure 12-23:

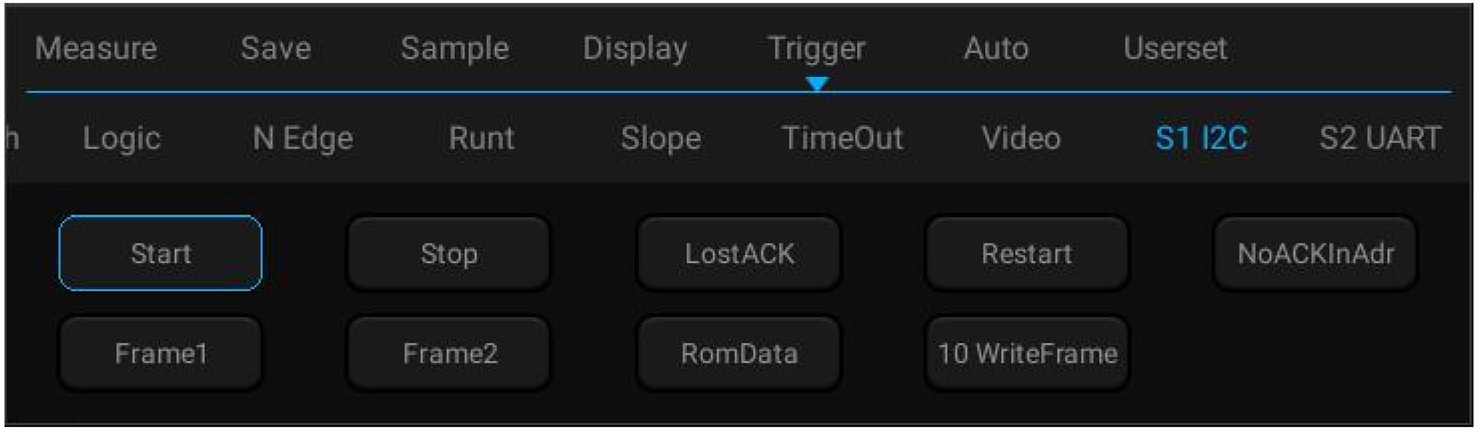


Figure 12-23 I2C Trigger Mode Configuration Menu

Trigger mode menu description:

a) Start condition — trigger when SCL is high and SDA has a falling edge (includes restart).

b) Stop condition — trigger when SCL is high and SDA has a rising edge.

c) Ack Loss — Trigger when the bus Ack bit is high.

d) Restart — triggered when a new start condition occurs before the stop condition.

e) Address no ack — trigger when the ack bit in the set address field is invalid (ignoring W/R bit), select "Address" in the trigger data, and use the pop-up virtual soft keyboard to modify it.

f) Frame Type 1 - Start + Address 7 + Read/Write + Acknowledge + Data; if all bits in the frame type match, trigger on read/write frames in 7-bit addressing mode on the 17th clock edge.

Frame type 1 operation method: Select values after the address/data, click values after the address/data on the touch screen, and modify them on the pop-up virtual soft keyboard.

g) Frame type 2 — Start + Address 7 + Read/Write + Acknowledge + Data 1 + Acknowledge + Data 2; trigger on read/write frames in 7-bit addressing mode on the 26th clock edge if all bits in the frame type match. The operation method of configuring frame type 2 is the same as frame type 1, and will not be repeated here.

h) EEPROM data read - When the read operation which contains 1010xxx control byte of the EEPROM appears on the bus and the Ack bit is correct, then the read data can be captured. If the captured data and the set data match the set relationship condition, trigger on the clock edge of Ack bit after the data byte.

After selecting “EEPROM Data Read”, click the relationship by “=” “ >” “<” “ ≠”, and the setting method is the same as the address field.

i) 10-bit write frame - Trigger on 10-bit write frame on the 26th clock edge if all bits in the pattern match.

Trigger mode is start condition, SCL connect to Ch2, SDA connect to Ch1, follow these steps as below:

(1) Tap S1 to open the decode channel, and click S1 again to open the bus configuration menu;

(2) Select the bus type as “I2C”, open the bus setting menu, and select the clock SCL as Ch2 channel;

(3) Open the trigger mode configuration menu and click “Start Condition” on the touch screen.

(4) Set the threshold level of two channels according to signal amplitude; I2C trigger graphic interface is shown in Figure 12-24:

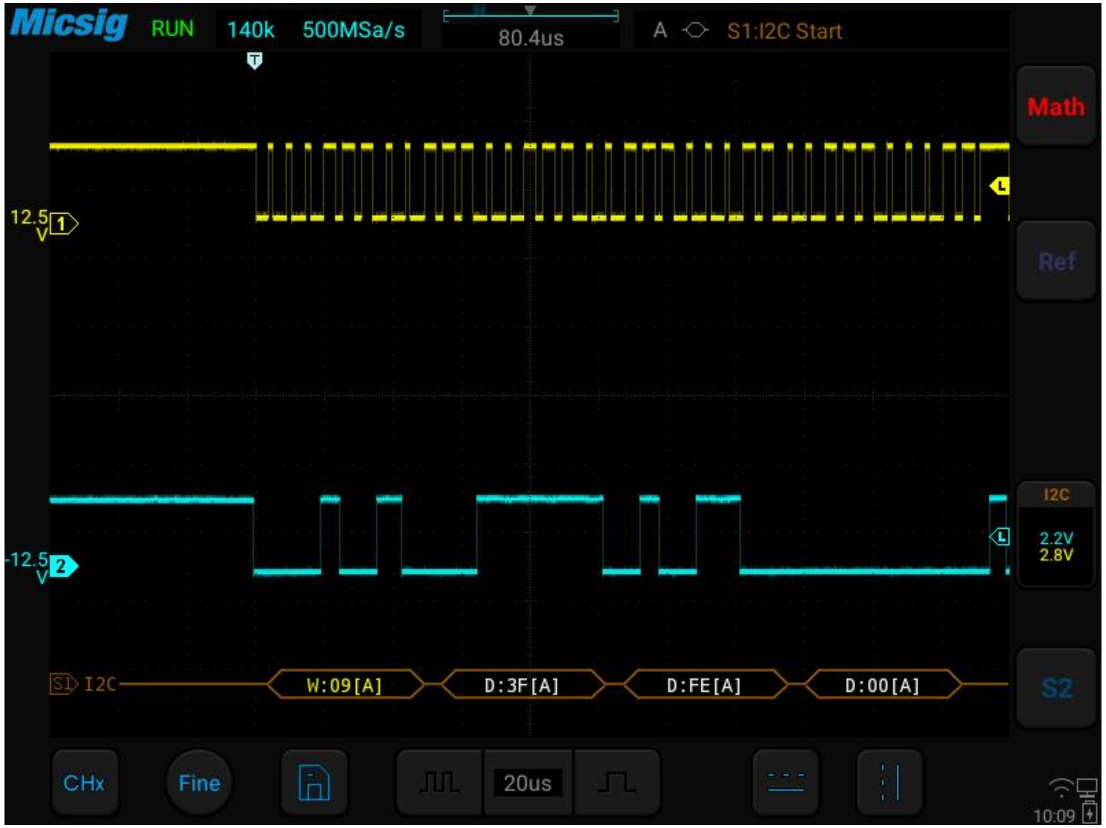


Figure 12-24 I2C Graphic Interface

I2C decode data packet description:

(1) Decode data packet displays real-time data about the bus activities.

(2) Decode data displays as hexadecimal system.

(3) Address content display: Read address displays in green, write address displays in yellow, and data displays in white. "W" denotes write operation, "R" denotes read operation, "D" denotes decode data, and "~A" denotes no Ack bit.

(4) When "?" appears, the time base needs to be adjusted to view decode results.

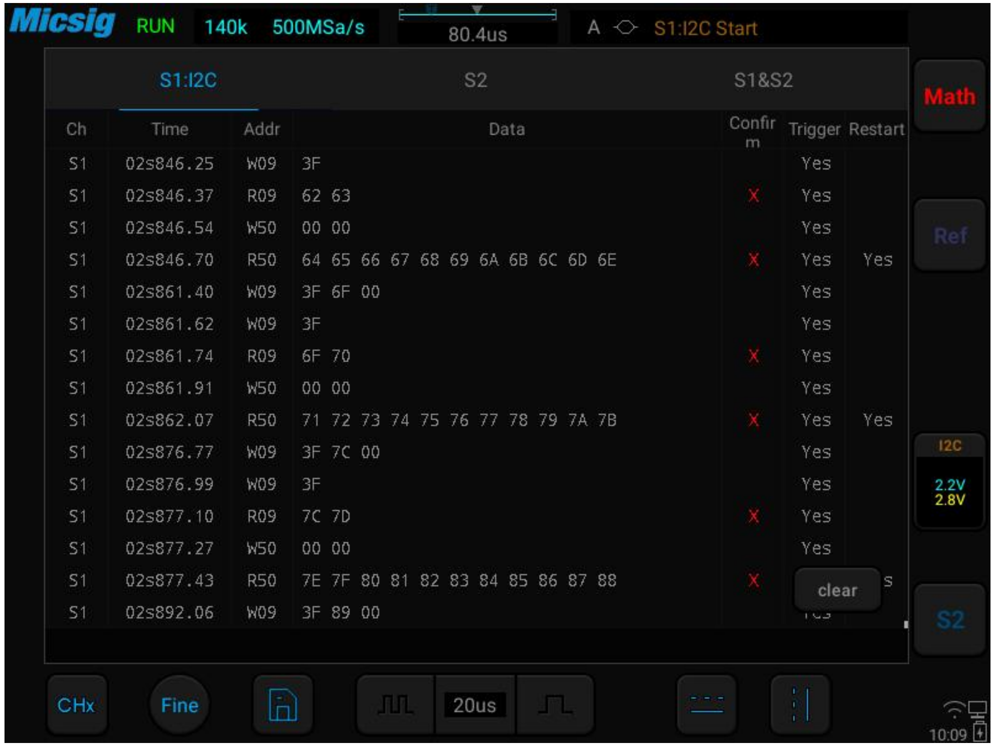


Figure 12-25 I2C Text Interface

I2C text interface description, as shown in Figure 12-25:

(1) “Ch”: bus channel.

(2) “Time”: intervals between the last read/write operations to current read/write operations

(3) “Address”: in address bar, “R” means the read operation, and “W” means write operation

(4) “Data”: data sent by one read and write operation is in the data bar.

(5) “Ack”: in Ack bar, “X” means Ack bit lost.

(6) “Trigger”: “Yes” means reach trigger condition.

(7) “Restart”: “Yes” means reach restart condition.

12.6 ARINC429 Bus Trigger and Decode

For correctly decoding ARINC429 bus data and making trigger stable, the bus configuration, trigger mode set and trigger level need to be adjusted.

- **Bus configuration**

Left swipe 

or 

to open the bus configuration menu, the following needs to be set:

Data Source — Select channel for ARINC 429 signal.

Word format — Select ARINC 429 decode mode.

Bus Display — Set the format for ARINC 429 decode data.

Baud Rate — Set the speed of ARINC 429 signal.

As shown in Figure 12-26:



Figure 12-26 ARINC429 Bus Configuration Menu

- **Trigger mode**

Open the trigger configuration menu and select the appropriate trigger type; when the ARINC429 bus trigger is selected, click the trigger type and relationship on the screen, as shown in Figure 12-27:

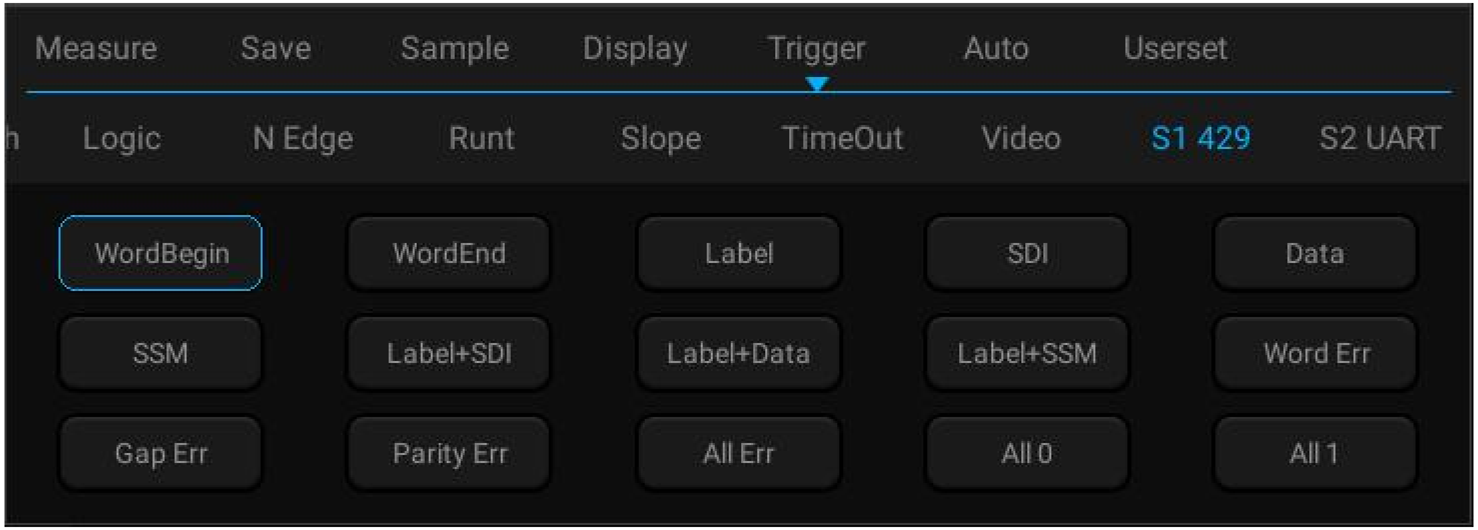


Figure 12-27 ARINC429 Trigger Mode Configuration Menu

If LABEL, SDI (source identifier), DATA or SSM (symbol/status mark) trigger are used, after selecting trigger mode, use the pop-up virtual keyboard to modify it, enter the value, and click “Enter” on the virtual soft keyboard to complete the setting.

Trigger configuration menu description:

a) Word start: Trigger at the word start.

b) Word stop: Trigger at the word stop.

c) LABEL: Label, triggered when the specified tag value occurs.

d) SDI: Source identifier, triggered on the specified source terminal.

e) DATA: Trigger on the specified data.

f) SSM: Symbol/status mark, triggered on the specified symbol status matrix.

g) LABEL+SDI: Trigger on the specified label and the specified source terminal.

h) LABEL+DATA: Trigger on the specified label and the specified data.

i) LABEL+SSM: Trigger on the specified label and the specified symbol status matrix.

j) Word Error - Triggered when a word error occurs.

k) Word gap error: Triggered when a gap error occurs.

l) Verification error: Triggered when a verification error occurs.

m) All errors: Triggered when any of the above errors occur.

n) All 0 bits: Triggered when any bit with the value of zero occurs.

o) All 1 bit -: Triggered when any bit with the value of 1 appears.

- **ARINC 429 serial decode**

The measured signal source is CH1, the decode format is LABEL+DATA, the display is in hexadecimal, the baud rate is 12.5kb/s, and the trigger mode is LABEL, operate as follows:

(1) Tap S1 to open the decode channel, and click S1 again to open the bus configuration menu;

Select bus type "429", source as "CH1", decode format as "LABEL+DATA", display in "hexadecimal", baud rate as 12.5kb/s.

(2) Open the trigger setting menu, select the trigger type as bus trigger, S1-ARINC429, the trigger mode is LABEL, and enter LABEL as "106" on virtual keyboard.

Adjust **High trigger threshold level** and **Low trigger threshold level** according to signal amplitude; and ARINC429 trigger graphic interface is shown in Figure 12-28:

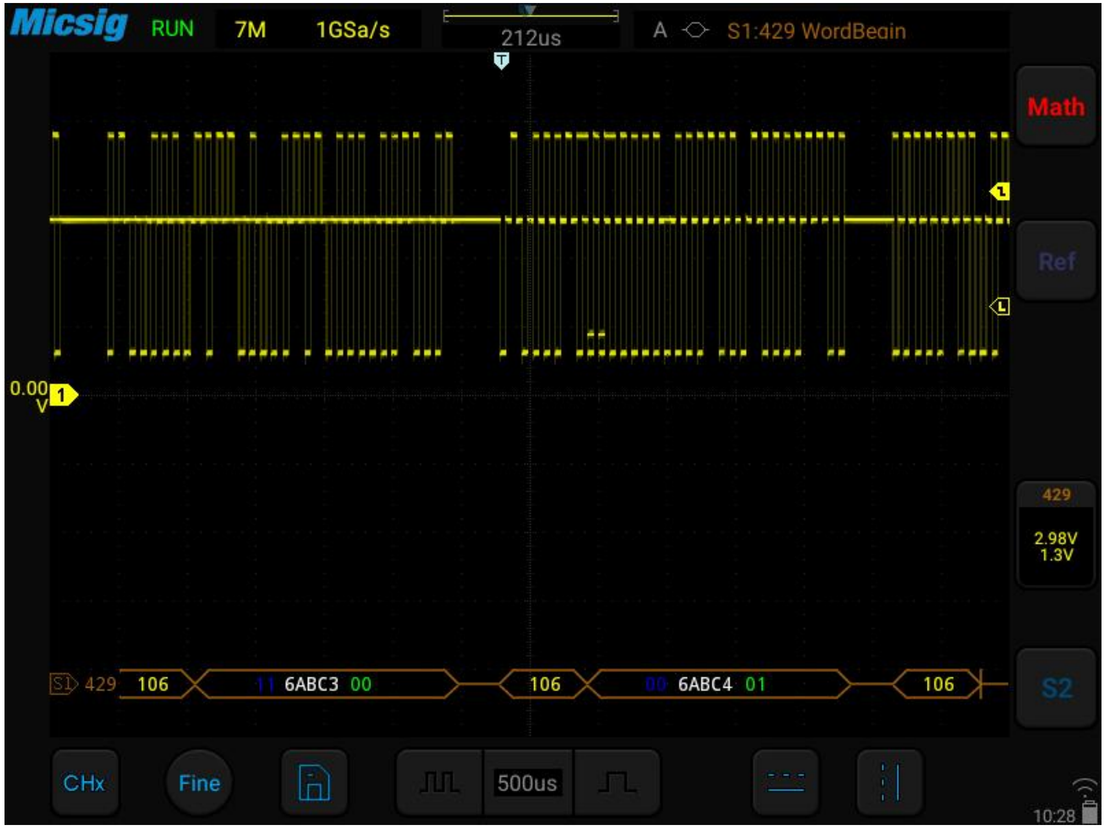


Figure 12-28 ARINC429 Graphic Interface

ARINC429 decode data packet description:

(1) Data packet, a total of 32bits, the data format is 8~1 (label bit, high bit first) +9~10(SD) +11~29 (data bit, low bit first) +30~31 (symbol status bit) +32 (parity bit)

(2) Label (8bits) - Displayed in octal: yellow

(3) SDI (2bits) - Displayed in binary: blue

(4) Data (19bits) - Displayed in selected numeration system: white, or red if there is parity error

(5) SSM (2bits) - Displayed in binary: green



Figure 12-29 ARINC429 Text Interface

ARINC429 text interface description, as shown in Figure 12-29:

(1) “Ch”: bus channel.

(2) “Time”: intervals between the last read/write operations to current read/write operations

(3) “LABLE”: label, information identifier, displayed in octal.

(4) “SDI”: source/target identifier, displayed in binary (displays XX if not identified separately).

(5) “Data”: content of the transmitted information, displayed in the selected numeration system.

(6) “SSM”: symbol/status matrix, displayed in binary (displays XX if not identified separately).

(7) “Error”: displays the frame error type (parity error Par, frame error Frm).

(8) “Trigger”: “Yes” means reach trigger condition.

12.7 1553B Bus Trigger and Decode

For correctly decoding 1553B bus data and making trigger stable, the bus configuration, trigger mode set and trigger level need to be adjusted.

- **Bus configuration**

  Left swipe 

 or 

 to open the bus configuration menu, the data source and display hexadecimal need to be set, as shown in Figure 12-30:



Figure 12-30 1553B Bus Configuration Menu

- **Trigger mode**

Open the trigger configuration menu and select the appropriate trigger type. When the trigger type is 1553B bus trigger, click the trigger type on the screen, as shown in Figure 12-31:



Figure 12-31 1553B Trigger Mode Configuration Menu

Trigger configuration menu description:

a) Command/status word sync header: Triggered at the beginning of the command/status word (at the end of valid C/S sync pulse).

b) Data word sync header: Triggered at the beginning of data word (at the end of valid data sync pulse).

c) Command/status word: Triggered when the specified command/status word is detected.

d) Remote terminal address: Triggered when RTA of command/status word matches the specified value.

e) If you select this option, RTA softkey will be available, allowing you to select the hexadecimal remote terminal address value to be triggered on it. If you select 0xXX (irrelevant), oscilloscope will trigger on any RTA.

f) Manchester coding error: Triggered when a Manchester coding error is detected.

g) Data word: Triggered when the specified data word is detected.

h) Odd parity error: Triggered when the odd parity bit is incorrect for data in the word.

i) All errors: Triggered when an error is detected.

- **1553B serial decode**

The measured signal source is CH1, the bus display is hexadecimal, the baud rate is 12.5kb/s, and the trigger mode is the command/status word sync header, and operate as follows:

(1) Tap S1 to open the decode channel, and click S1 again to open the bus configuration menu;

(2) Select the bus type as “1553B”, source as “CH1’, and display in “hexadecimal”.

(3) Open the trigger setting menu, select the trigger type as bus trigger, 1553B, and trigger mode as "command/status word sync header".

Channel **threshold level** is adjusted according to signal amplitude. 1553B trigger graphic interface is shown in Figure 12-32:

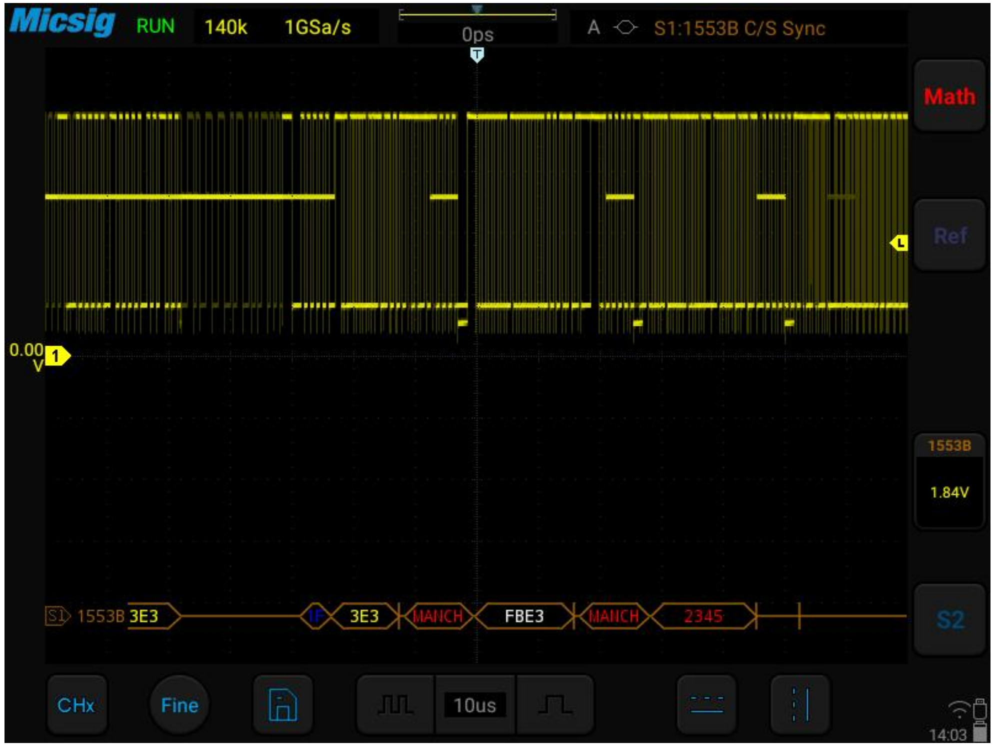


Figure 12-32 1553B Graphic Interface

1553B decode data packet description:

(1) Remote terminal address (5-bit data): blue

(2) The value of remaining 11 bits of the command/status word: yellow

(3) Decoded data: white

(4) If the command/status or data word has a parity error, its decoded text is displayed in red instead of green or white.

(5) The sync error is displayed together with the word “SYNC”.

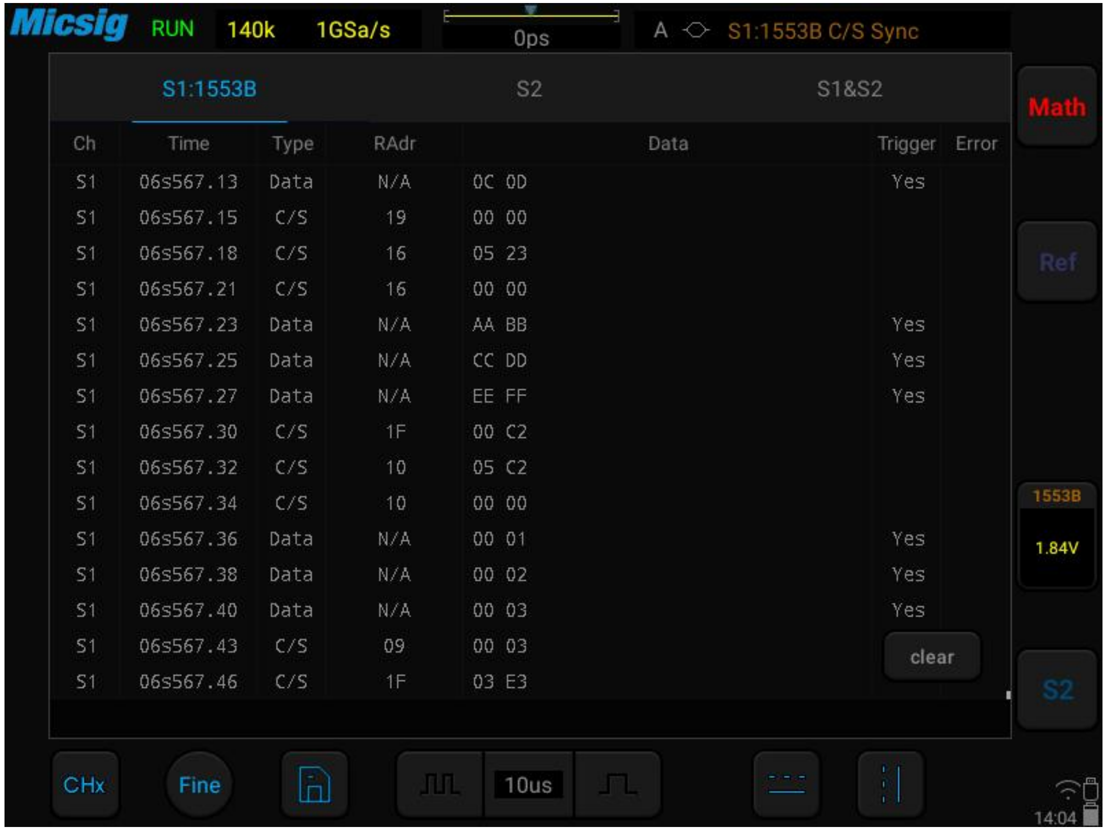


Figure 12-33 1553B Text Interface

1553B text interface description, as shown in Figure 12-33:

(1) "Ch": bus channel.

(2) "Time": intervals between the last read/write operations to current read/write operations.

(3) "Type": frame type (data frame DATA, command/status frame C/S, others N/A).

(4) "RAdr": remote terminal address, displayed in the selected numeration system (N/A for no content display).

(5) "Data": content of the transmitted information, displayed in the selected numeration system.

(6) "Trigger": "Yes" means reach trigger condition.

(7) "Error": displays the frame error type (parity error Par, Manchester coding error M-ch).

Chapter 13 Homepage Functions

This chapter contains the functions of the oscilloscope homepage and describes the functions of all icons on the homepage and settings. You are recommended to read this chapter carefully to understand the homepage functions of the Smart series oscilloscope.

- Oscilloscope
- App Store
- Settings
- File manager
- Calculator
- Browser
- Gallery
- Calendar
- Electronic Tools
- Clock
- Power Off

The following figure shows the contents of the oscilloscope home page. Slide left or right to display the remaining applications. See Figure 13-1.

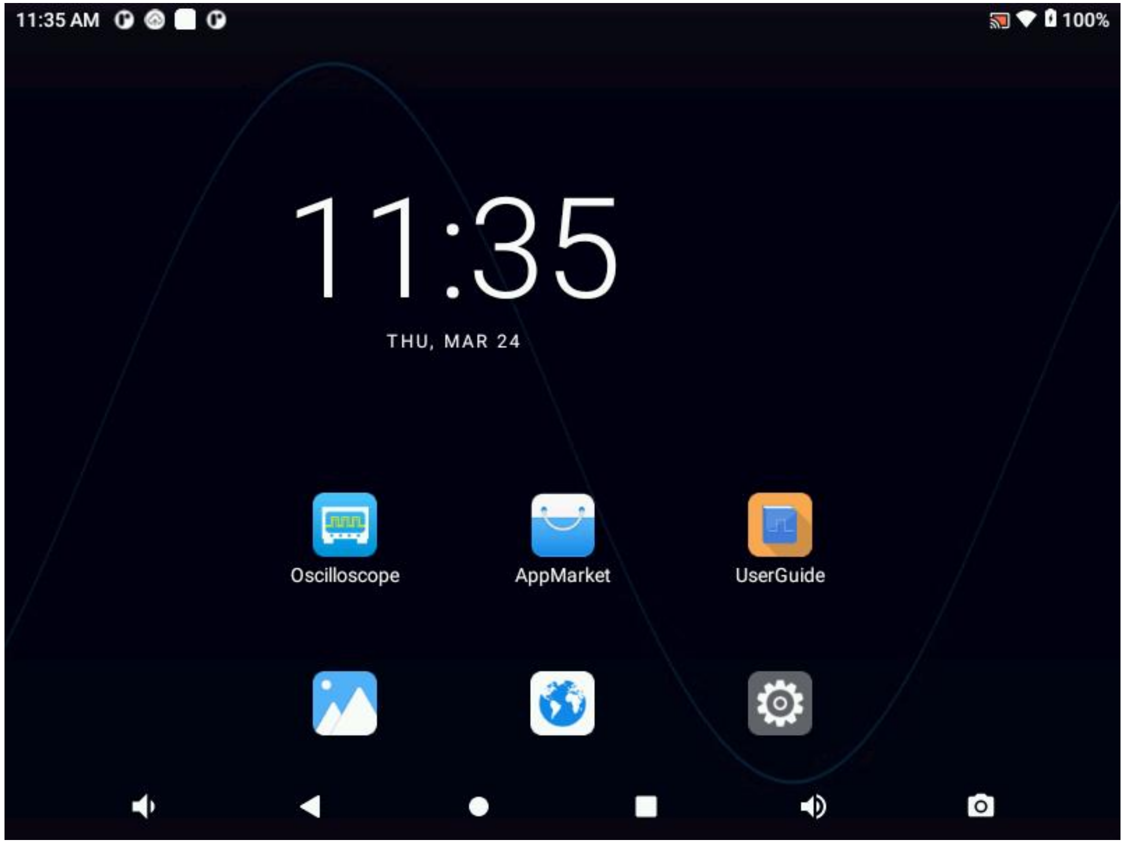


Figure 13-1 Homepage Interface

13.1 Oscilloscope (see Chapters 2~12)

13.2 App Store

Tap the app store icon on the homepage to go to the app store interface, as shown in Figure 13-2. App store content includes Network, Local, U-disk, and About.

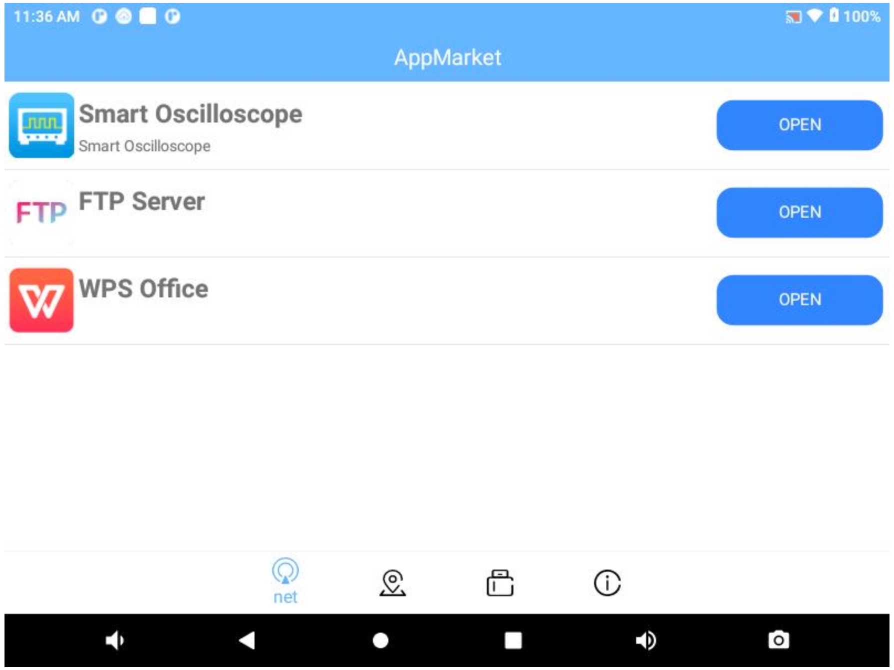


Figure 13-2 App Store

Network

Tap “Network” to open the application list.

Tap app icon to view details such as version number of the current app and app description, and tap the green open option below to open or install the current app.

Tap the green option on the right of the app list to open and install the app.

Local

Apps that have been downloaded and installed are displayed locally. When there is no downloaded application installation package file locally, the interface will display “There are no available apk files in the local directory”.

U-disk

The U disk interface will display applications that can be opened in the USB disk.

If the USB disk is not plugged, the interface displays “U-disk not inserted”.

After USB disk has been plugged, if there are no apk files in the USB device for installation, the interface displays "There is no available apk file in the U disk directory".

About

In "About" interface, the equipment model, bandwidth, serial number, version information, shipment date and information about installed options can be viewed. Open the virtual keyboard and enter the license to install the corresponding options.

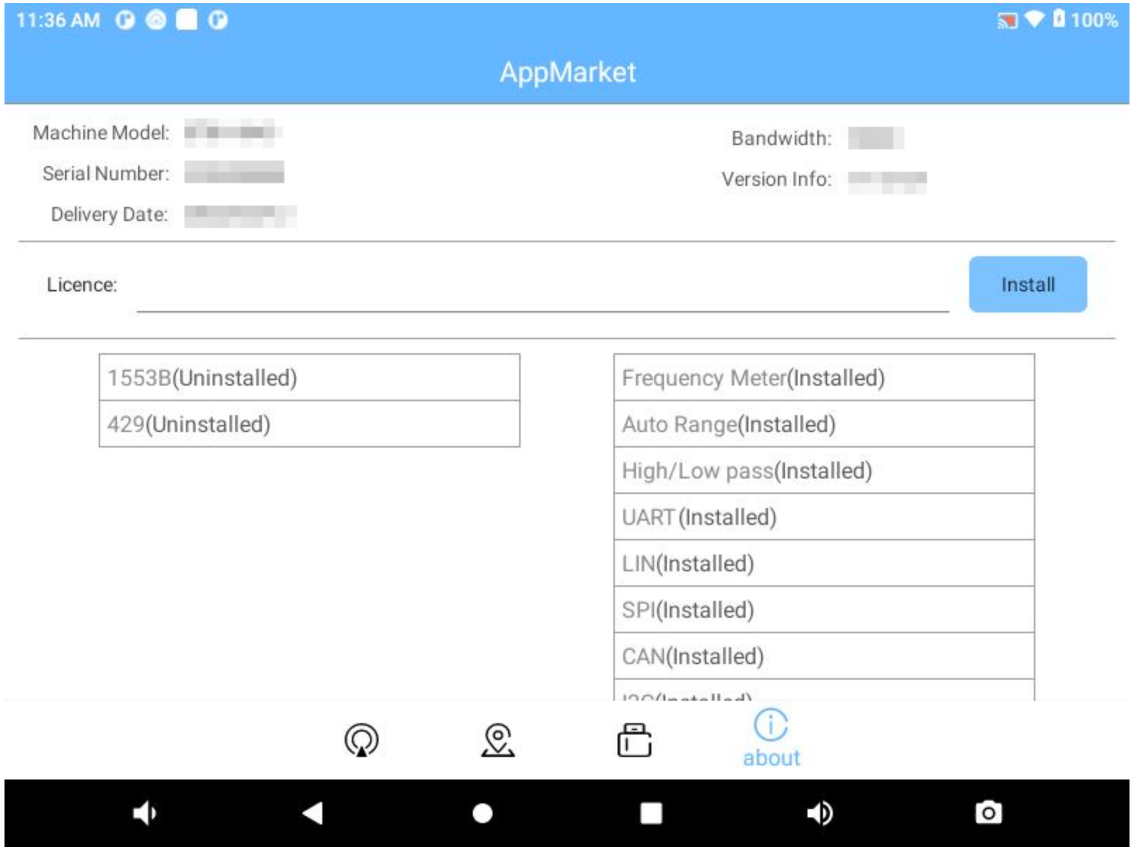


Figure 13-3 About Interface

The options that can be installed include: UART, LIN, SPI, CAN, I2C, 1553B, 429 and other serial decode (refer to Chapter 12 Serial Bus Trigger and Decode).

13.3 Settings

Tap settings on Homepage to enter the System Settings interface. Settings on the settings interface include Network & internet, display, sound, storage, system and About Oscilloscope, as shown in Figure 13-4.

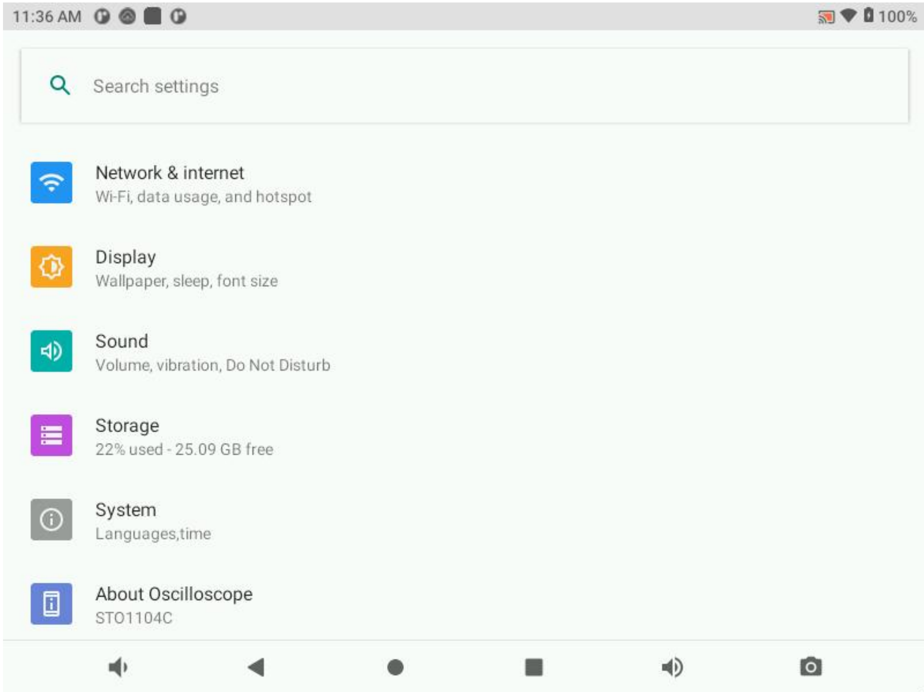


Figure 13-4 System Setting Interface

WLAN connection

Tap WIFI icon to enter the WLAN settings interface, as shown in Figure 13-5.

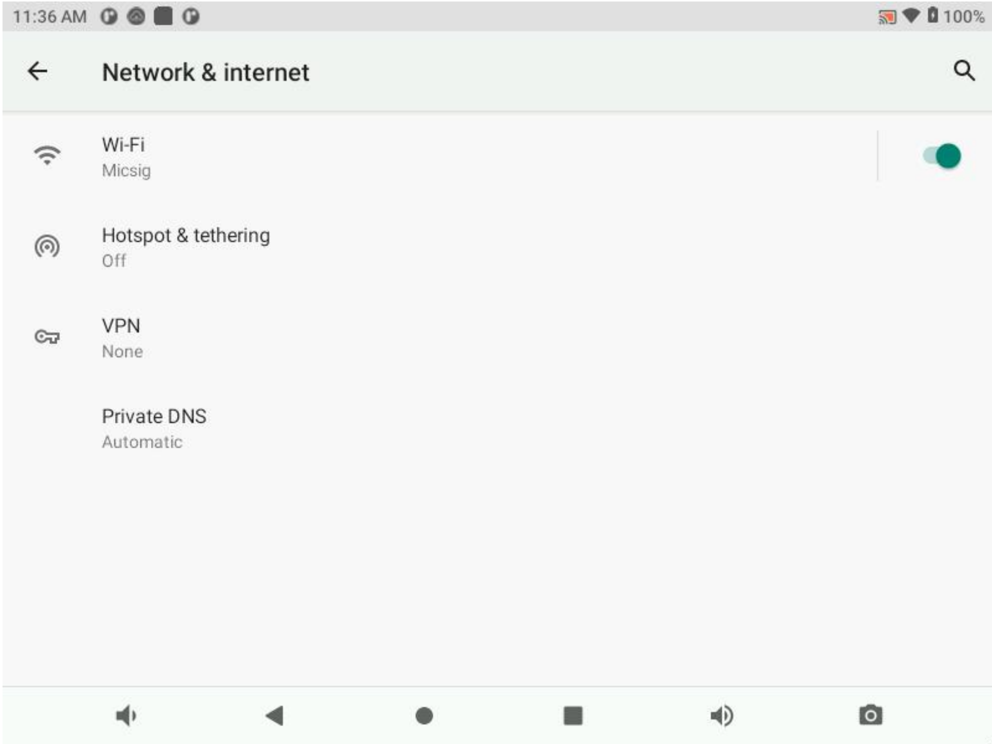


Figure 13-5 WLAN Connection Setting

Tap on/off bar to turn the WLAN function on. Oscilloscope can automatically scan the surrounding wireless networks and display their names by list.

Tap the wireless network to be connected and the password input box will pop up. After entering password using the virtual keyboard, tap Enter to connect oscilloscope to the wireless network.

Click the current network can advanced settings for WIFI.

Portable WLAN hotspot

Tap **Hotspot** to enter the portable hotspot settings interface.

Tap the off icon to open the hotspot. Click “hotsopt name” to enter the network name and password using the virtual keyboard, as shown in Figure 13-6. Other equipment can share oscilloscope files by linking oscilloscope hotspots (portable hotspot default IP is: 192.168.243.155).

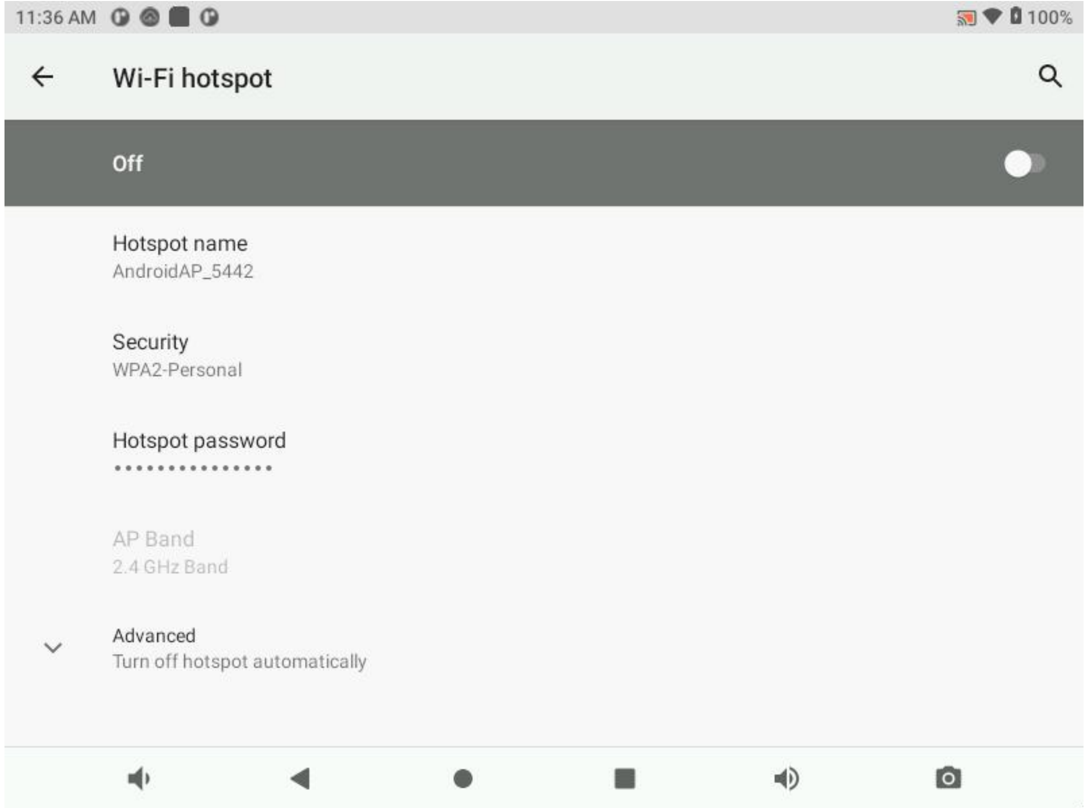


Figure 13-6 Portable WLAN Hotspot Setting

Display

Tap display icons to set the oscilloscope Brightness level, Dark theme, Wallpaper, Font size and Display size.

Brightness level: The progress bar can be dragged to set the brightness of the screen display.

Dark theme: Set Dark theme uses a black background to help keep battery alive longer on some screens.

Wallpaper: Set the screen wallpaper.

Font size: Change the system display font size.

Display size: Make the items on your screen smaller or larger. Some apps on your screen may change position.

Sound

Tap the “sound” icon and drag the progress bar in the sound section to change the media volume, alarm volume and notification volume. After clicking the default notification ring tone, drag up and down to select the ring tone, then click OK.

Storage

Tap storage to enter the storage space view interface, then view the total storage capacity, size of available space, as well as memory size of applications (application data and media content), pictures, videos, audio (music, ringtones, podcasts, etc.), download content, cache data, and others.

If USB device is plugged, it will display the total storage capacity and available memory size, and can also uninstall and format SD card.

Language and input method

Tap System →language & input icons to set your system language and input method.

Language: add a language and drag it to the first position of language list to make it as system language.

Spell Checker: When this function is turned on, it will automatically check for correctness as you type.

On-screen keyboard includes Android keyboard and Gboard, tap +manage on-screen keyboards to turn off one of them.

Advanced setting include Spell checker, Autofill service, Personal dictionary, Pointer speed.

Date and time

Tap System →Date & time icons to set your system date and time

Use network-provided time: When turned on, the time provided by the network will be used as the system time. Date and time cannot be set manually after turning this on.

Set date: Set the system date manually.

Set time: Set the system time manually.

Select time zone: Set the time zone manually.

Use 24-hour system: If on, the system time will be 24-hours, and off for 12 hours.

About Oscilloscope

In the “About” interface, view legal information, Android version, IP address, build number and other information.

Accept online updates: turn off/on System update, app update, boot interface update, userguide update ...

13.4 File Manager

File manager app can enable quick access to and management of various files stored on the equipment.

Tap the Files app icon on the homepage screen to enter the file manager interface.

Recent: shows files that have been opened recently

Classification: views files by types, including images, videos, Audio, Documents, Downloads, STO etc.

Local: views the content stored in the oscilloscope by the traditional folder list mode. When USB device is plugged, the content in the USB device can also be accessed through external storage.

To operate files, simply press and hold a single file to select it. The selected file will show blue √. Then, click the remaining files to select them. If all files must be selected, tap the ⋮ icon at the right top of the screen and click Select all, which also includes copy, cut, compress, rename and more operations. Tap the trash icon to delete files.

13.5 Calculator

Tap calculator icon on the homepage to open the calculator app.

Calculator can perform simple addition, subtraction, multiplication and division calculations as well as scientific calculations.

13.6 Browser

Tap the browser icon on homepage interface to enter the browser interface, and then it can access to the internet if the network condition is good, as shown in Figure 13-7.

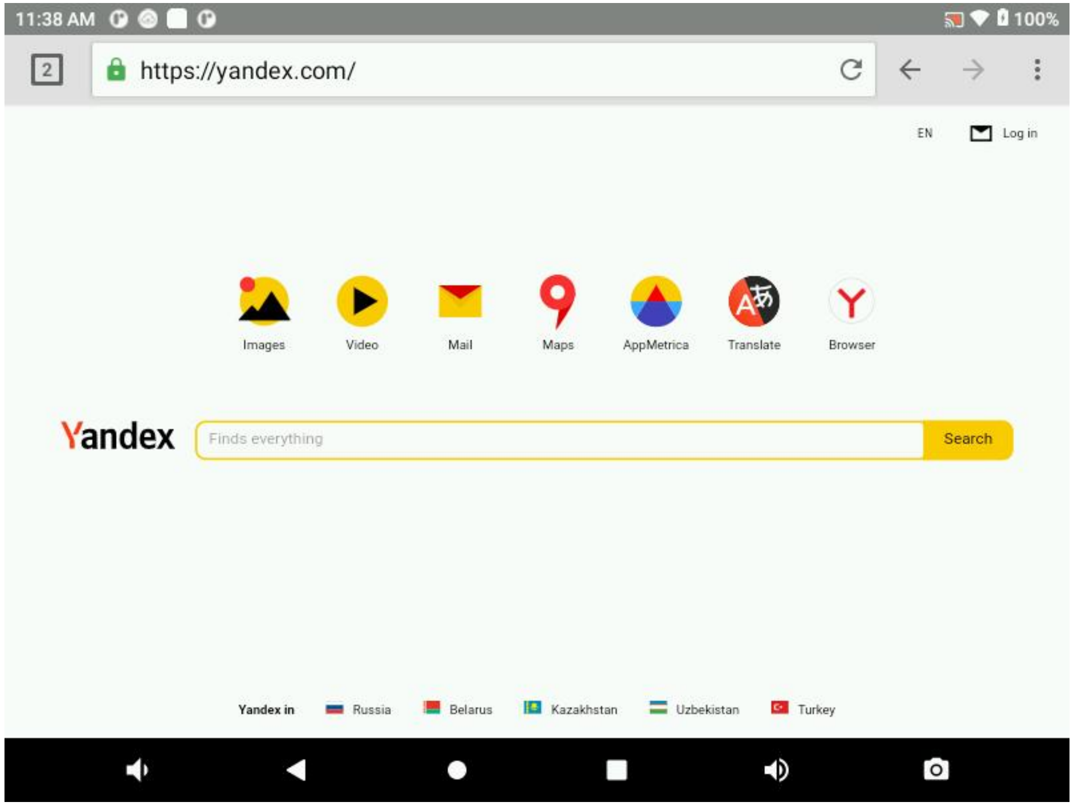


Figure 13-7 Browser Interface

13.7 Gallery

Tap gallery application on the homepage interface to enter the picture viewing interface, as shown in Figure 13-8.

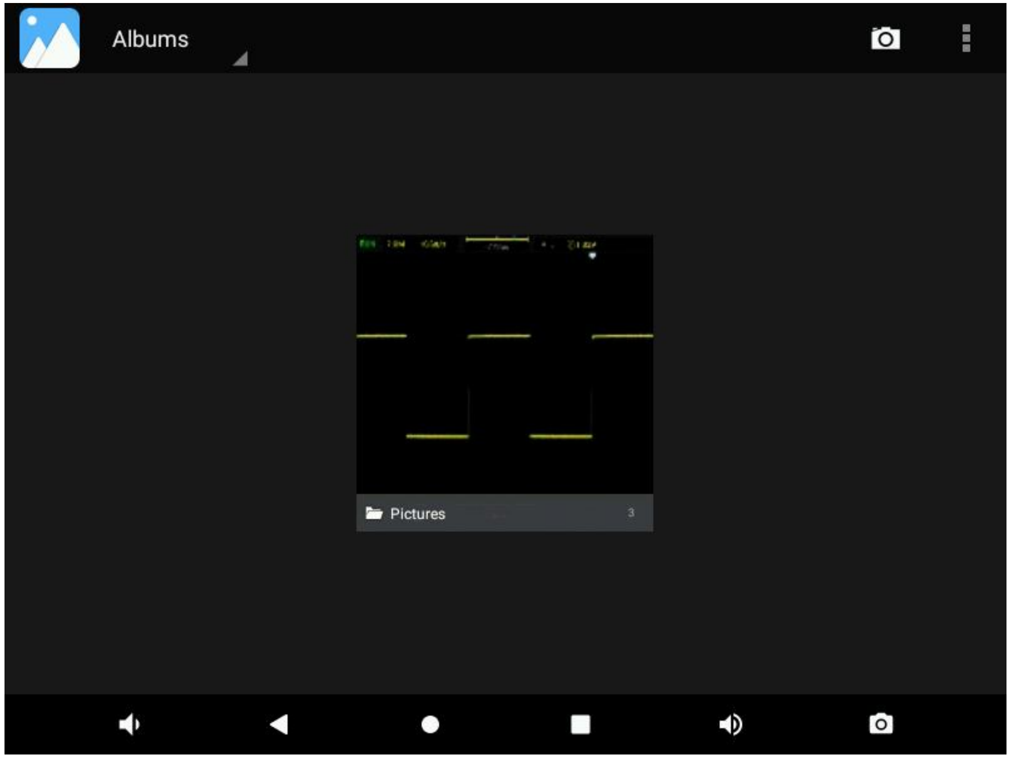


Figure 13-8 Picture Viewing Interface

Gallery provides locally stored photos/videos with the functions of picture/video viewing and photo editing.

In the picture view interface, pictures and videos can be classified into different categories according to the method in the upper left corner, and tap them to view pictures or videos.

When viewing pictures, click to display them in full screen. When viewing videos, swipe left and right to select the video you want to play. Click the triangle play button, and the video will play automatically. Tap the screen to pause play. Drag the pictures left and right when displaying in full screen to view previous and next pictures. Tap the back button to exit the full screen display, as shown in Figure 13-9.

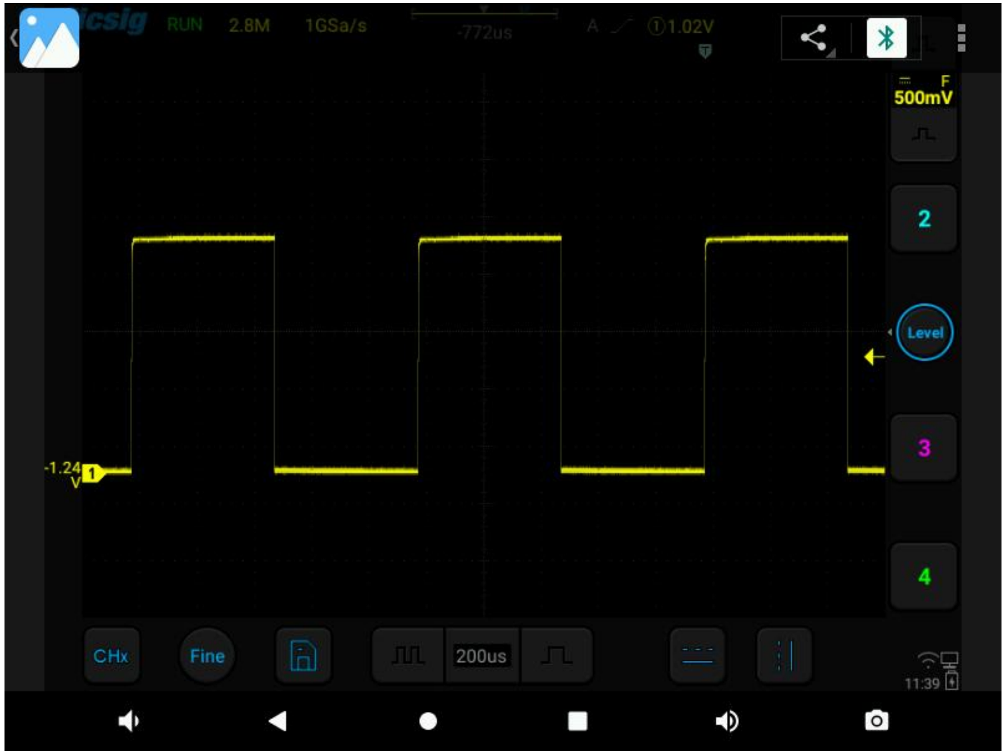


Figure 13-9 Full-Screen Picture Viewing Interface

When viewing pictures and videos, tap the option at the top right of the screen and click to select items. The pictures and videos can be selected. Click the recycle bin icon in the upper right corner of the screen to delete pictures or videos.

After the USB device is connected to oscilloscope, if there are pictures or videos in the USB device, they will be automatically displayed on the picture viewing interface.

13.8 Calendar

Tap the calendar app icon on the homepage to enter the calendar interface.

Tap TODAY at the top right of the screen to navigate directly to today's date.

Tap the date at the top left of the screen to adjust the calendar display style by day, week and month.

13.9 Electronic Tools

Electronic tools can provide a convenient set of electronic calculation tools.

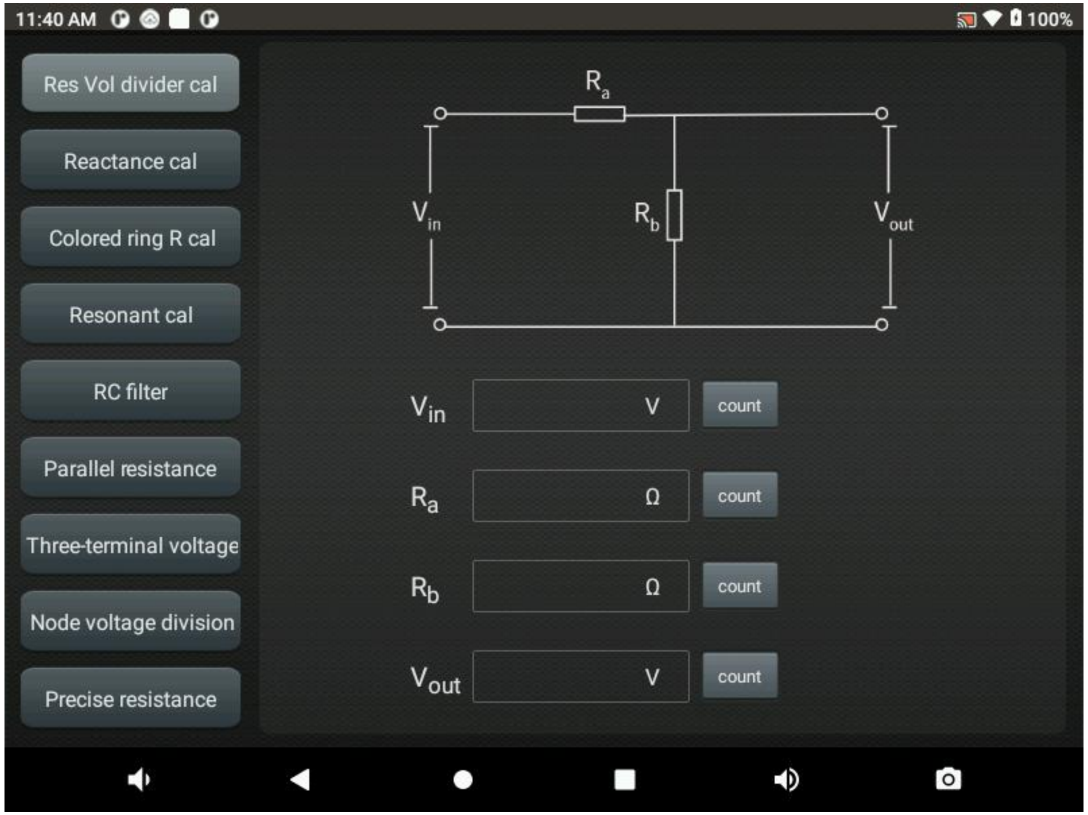


Figure 13-10 Electronic Calculation Tool Function

13.10 Clock

Tap time icon on the homepage or tap clock app icon to enter the clock settings screen, as shown in Figure 13-11.

Alarm clock

Add an alarm: Click "+" button below to add an alarm clock and create settings.

Alarm time: Drag pink dot in the dial to set the hour, and drag again to set the minute.

Repeat: Monday to Sunday available and click calendar icon on the right to enter the calendar for custom selection.

Alarm ringtone: Select alarm ringtone, support local ringtone, system ringtone, none.

Label: The alarm will be displayed on the screen when it rings.

Delete alarm: Click the alarm to be deleted in the list and select "delete" at the bottom of the alarm edit page.

Switch status: Click the switch behind the alarm to turn it on and off.

World clock

Add region: Click the bottom globe button and select city in the list of cities.

Timer

Add timer: Enter the hour, minute and second, click the triangle button to start countdown.

Delete timer: Click “DELETE” to delete the timer.

Pause: Click the double rectangle button to pause timer.

Stopwatch

Start: Click “Triangle” to start timing.

Pause: Click “Double Rectangle” below to pause the stopwatch.

Mark: Click the LAP to mark it.

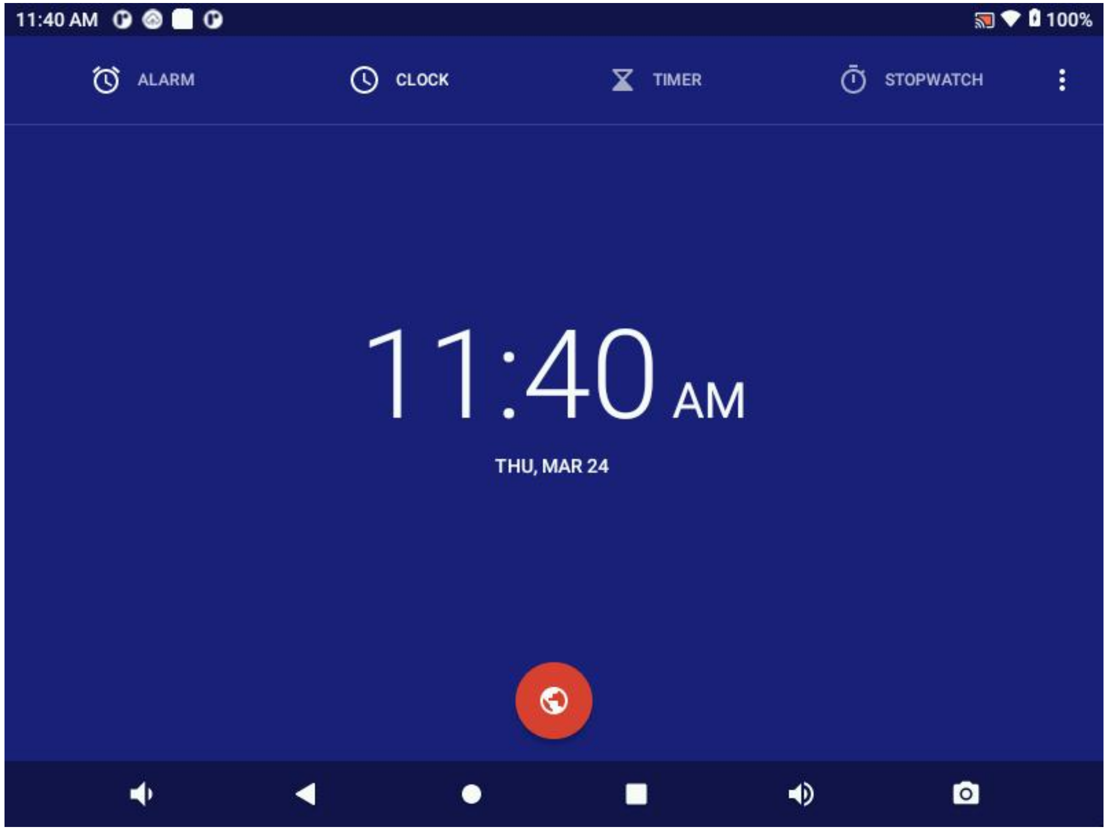


Figure 13-11 Time Setting

13.11 Power Off

Long press power button ⏻ to enter the power off interface, as shown in Figure 13-12. Power off contains 2 options: power off, restart.

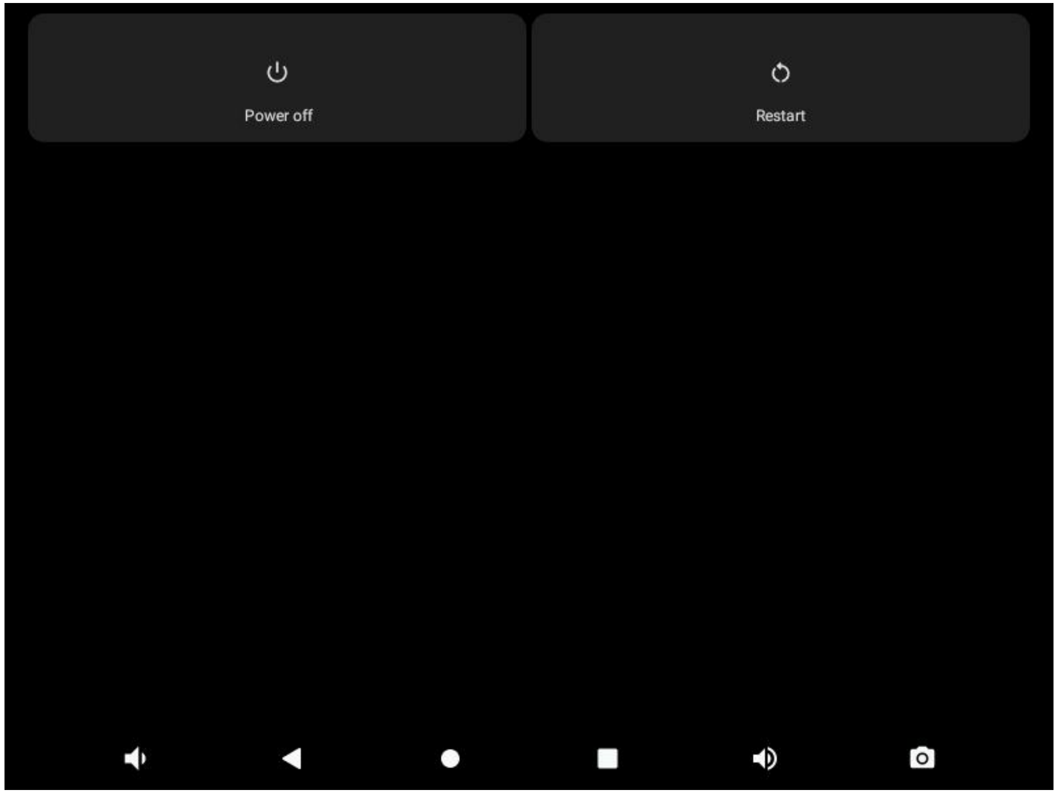


Figure 13-12 Power Off Interface

Power off: Tap  icon to turn off the oscilloscope.

Restart: Tap  icon to restart the oscilloscope.

Chapter 14 Remote Control

This chapter contains the application of host computer, mobile remote control, in order to understand remote control functions of the Smart series oscilloscope.

- Host computer
- Mobile remote control

14.1 Host Computer

To control the instrument using the host computer software, you need to install the NI driver first, then the RemoteDisplay software is downloaded and installed. This software is only suitable for Micsig Smart Series oscilloscopes.

14.1.1 Installation of Host Computer Software

Note: The host computer software only supports Win7 or higher edition operating system. The computer needs to install NI-VISA driver first.

The host computer and needed NI-VISA driver can be downloaded from Micsig offical website: http://www.micsig.com

Download the host computer software on official website of Micsig, open RemoteDisplaySetup.exe file, and complete the software installation.

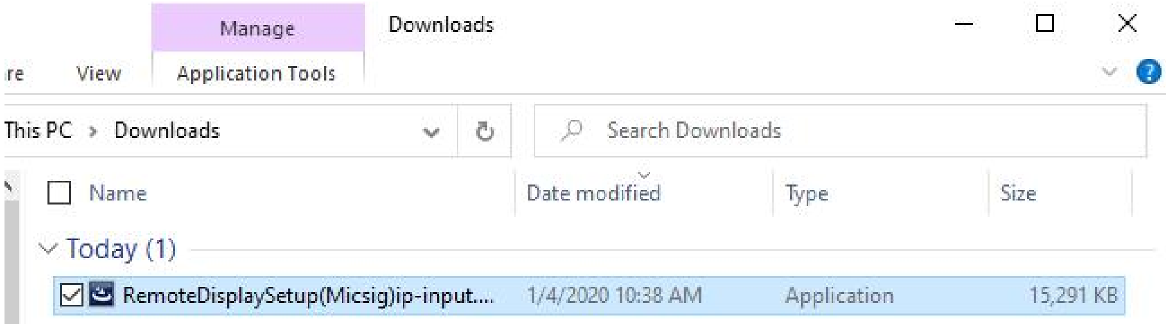


Figure 14-1 RemoteDisplay Software

14.1.2 Connection of Host Computer

USB connection: Connect USB Device to the computer and oscilloscope through USB data cable. After the computer recognizes the USB device, open the host computer, set the connection mode to USB 

, and display the device information in the device information display box in the lower right corner. This indicates that the oscilloscope has been found. Click to connect to the selected oscilloscope.

WIFI connection: Under the oscilloscope settings →WLAN menu, choose and connect the same WIFI with the computer to ensure that **the computer and the oscilloscope are in the same network**. Open the host computer, set the connection mode to Net 

, and display the device information in the device information display box

in the lower right corner. This indicates that the oscilloscope has been found. Click to connect to the selected oscilloscope.

Enter IP connection: In case of network connection (WIFI or LAN), directly type oscilloscope IP to be connected in the oscilloscope device information display box in the lower right corner, and then click the oscilloscope connection status button, the host computer will be connected to the oscilloscope corresponding to the entered IP address.

14.1.3 Main Interface Introduction



Figure 14-2 Host Computer Interface

1. Host computer on/off button	Click to exit the host computer software

2. Oscilloscope connection status button	The button has two states: Green: Connect to selected oscilloscope when clicked Red: Disconnect from oscilloscope when clicked
3. Quick camera button	Click to take photo quickly. Pictures are stored in the local directory C:\Users\Public\Pictures
4. Video record button	Click to open or close video record function. Videos are stored in local directory C:\Users\Public\Videos
5. Host computer storage button	Set photo taking and video recording storage locations
6. Net USB Select oscilloscope connection mode	USB and WIFI connections are available **Note: WIFI connection must ensure that oscilloscope and computer are in the same network**

7. Host computer display area	Synchronous display with oscilloscope
8. Oscilloscope information display	Display oscilloscope model, connection mode, SN, IP and other information, select the oscilloscope to be connected
9. Host computer waveform control area	Waveform control area button has the same function with that button on the oscilloscope

14.1.4 Operation Interface Introduction

The host computer and the oscilloscope are synchronously displayed, and the waveform operation mode and the menu opening and closing mode are the same as those on the oscilloscope; the left mouse button and the single finger operation mode are the same, and both of them can perform the operations of slide, click, drag, etc.

14.1.5 Storage and View of Pictures and Videos

Storage setting of pictures and videos:

Open the host computer storage setting , set the storage location of pictures and videos, as shown in the figure below:

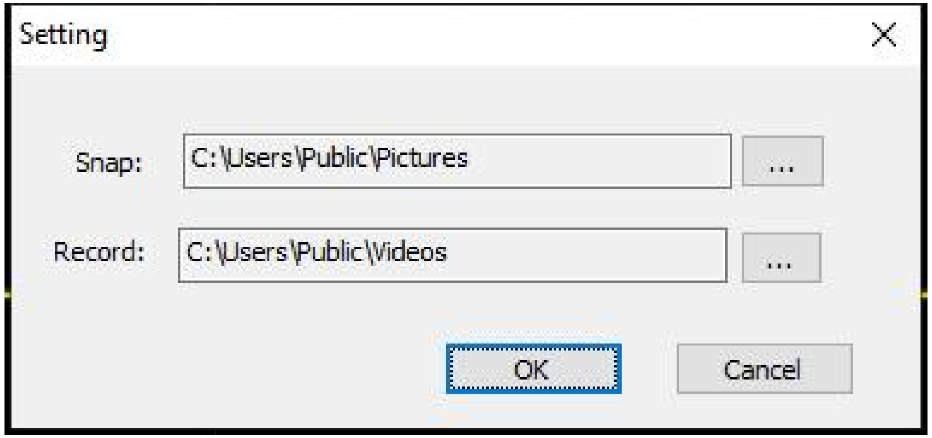


Figure 14-3 Host Computer Storage Setting

Pictures are stored in the local directory C:\Users\Public\Pictures by default. We can also store them under the directory defined by ourselves according to our own needs. For example, we store pictures in a “mini photo” directory under E-drive disk. We can set the video storage location in the same way, then click OK.

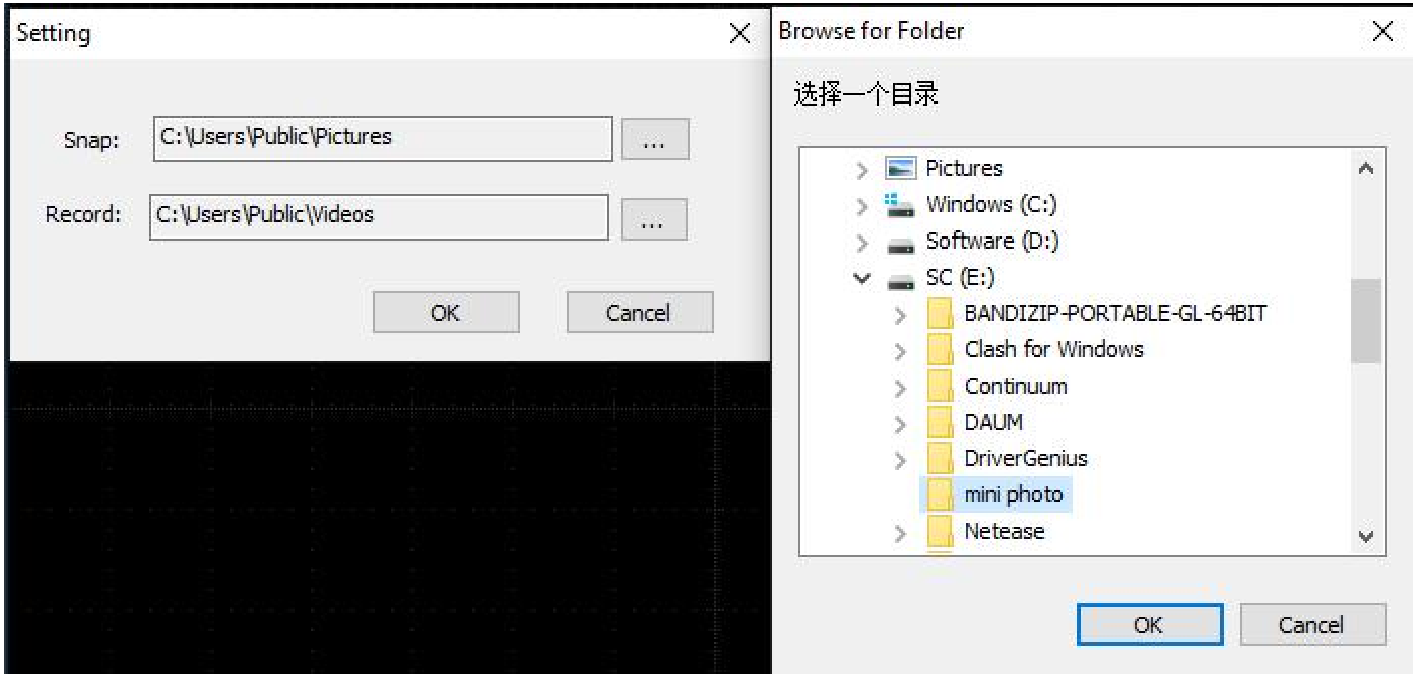


Figure 14-4 Change Storage Directory

View pictures and videos:

Open picture (video) storage directory to view pictures (videos) stored on the host computer.

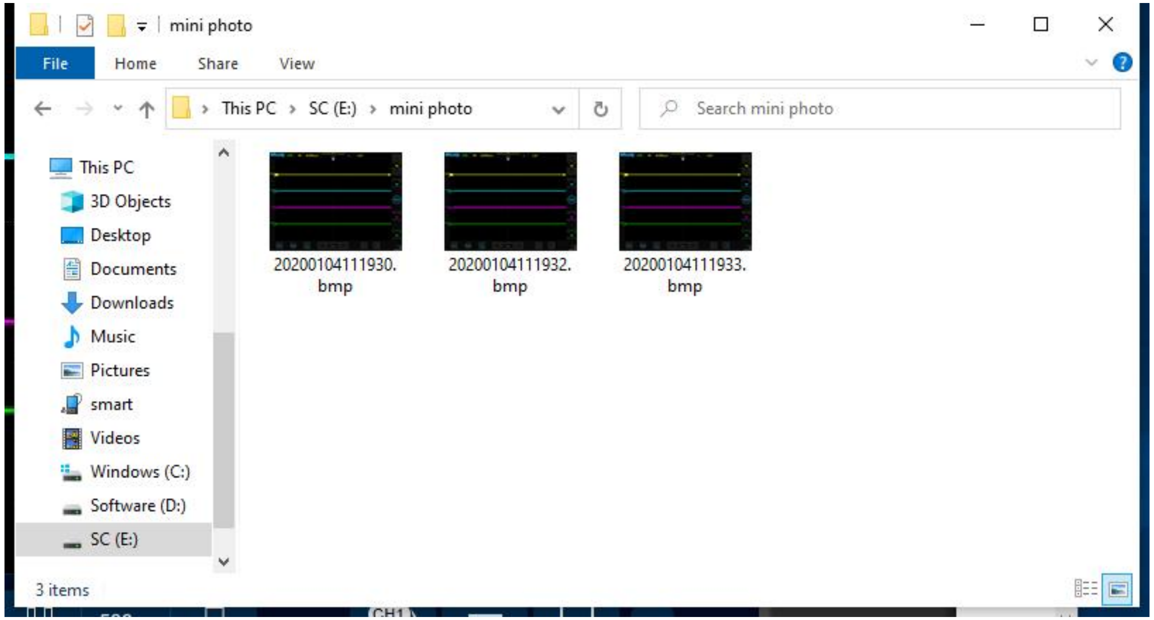


Figure 14-5 View Pictures

14.2 Mobile Remote Control

Micsig Smart series oscilloscopes support remote control on mobile phone (android & iOS). You need to download Android app from the official website of Micsig (address: http://www.micsig.com) and install it. For iOS, go to apple store search Tablet Oscilloscope or Micsig to get it.

After App is successfully connected, mobile device can be used to control the oscilloscope and display the oscilloscope interface in a real time manner.



Figure 14-6 APP interface



Figure 14-7 Successful Connection of APP

Android APP can be connected by two methods:

1. Use oscilloscope portable hotspot: Mobile phone can be connected to the hotspot of oscilloscope. Enter the oscilloscope IP 192.168.195.149 in the IP box at the lower right corner of the screen to connect successfully for control;

2. Connect mobile phone and oscilloscope to the network segment under the same router: view the IP address of the oscilloscope, and enters such IP address in the lower right corner of the mobile phone to connect successfully.

The first connection method is recommended.

Chapter 15 Update and Upgrade Functions

This chapter describes the methods of software update and increasing the optional function. You are recommended to read this chapter carefully understand the upgrade functions of the Smart series oscilloscope.

- Software update
- Add optional functions

15.1 Software Update

Micsig often releases software updates for its products. To update your oscilloscope software, you can connect the oscilloscope to WIFI for networking, and open the SystemUpgrade application to check and install update.

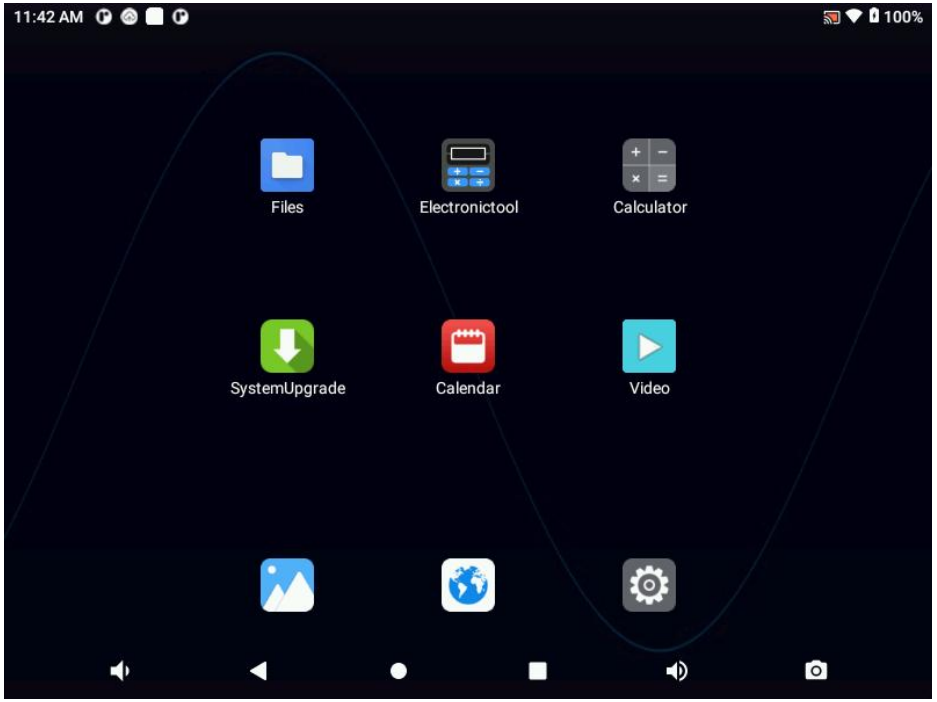


Figure 15-1 SystemUpgrade application

⚠ **Note:** Please pay attention to keep the oscilloscope power more than 50% when installing updates or connect the oscilloscope to the adapter, so as to prevent the oscilloscope from becoming abnormal due to insufficient power for update.

To view the currently installed software and firmware, tap the “App Store” software in the “Home” page to display the oscilloscope software and firmware information on the “About” screen. Please refer to 13.2 App Store.

15.2 Add Optional Functions

Tap the “App Store” software in the “Home” page to display the installed and uninstalled decoded options on the “About” screen. Please refer to 13.2 App Store.

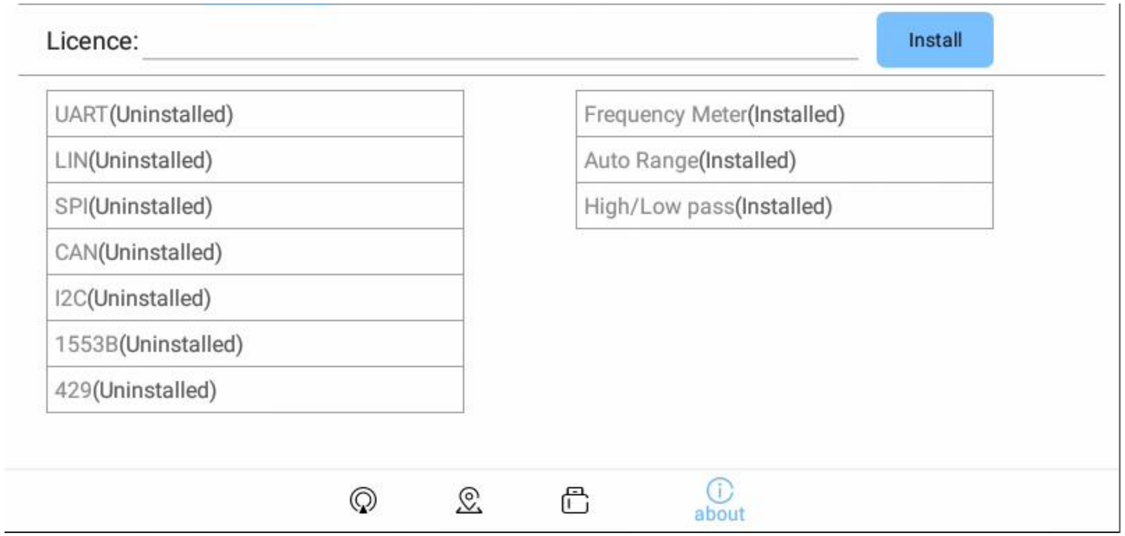


Figure 15-2 Decode Functions Not Installed

If you need the optional function service, please contact Micsig for license and enter the install option function at the license bar.

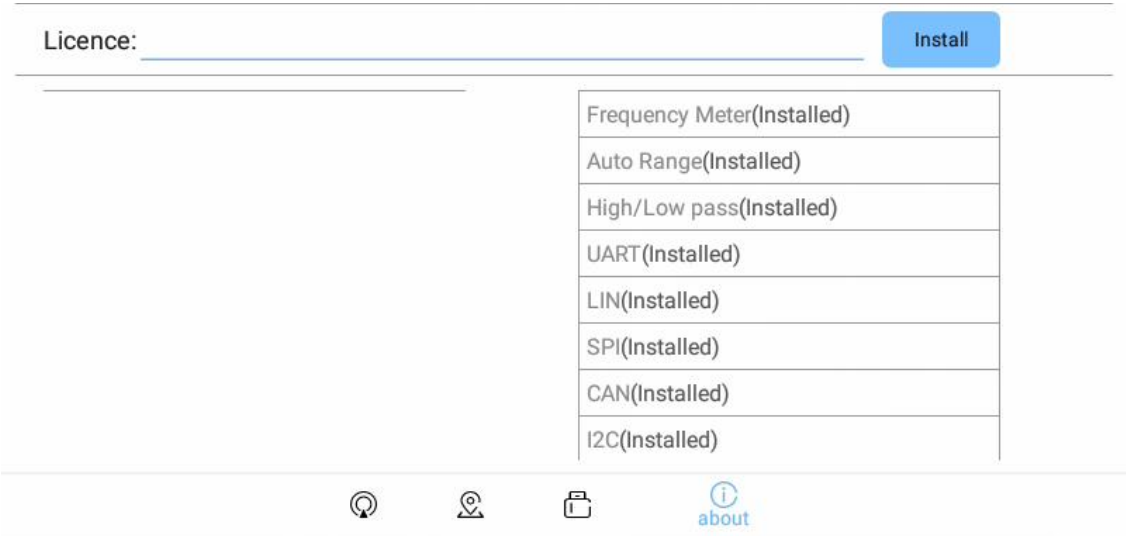


Figure 15-3 Decode Functions Installed

Chapter 16 Reference

This chapter contains the measurement category suitable for the oscilloscope and the environmental level of pollution degree supported. You are recommended to read this chapter carefully to understand the conditions of use of the Smart series oscilloscope.

- Measurement Category
- Pollution Degree

16.1 Measurement Category

Oscilloscope measurement category

Smart oscilloscopes are primarily used for measurements in Measurement Category I.

Measurement category definitions

Measurement category I is for measurements performed on circuits not directly connected to MAINS. Examples are measurements on circuits not derived from MAINS, and specially protected (internal) MAINS derived circuits. In the latter case, transient stresses are variable; for that reason, the transient withstand capability of the equipment is made known to the user.

Measurement category II is for measurements performed on circuits directly connected to the low voltage installation. Examples are measurements on household appliances, portable tools and similar equipment.

Measurement category III is for measurements performed in the building installation. Examples are measurements on distribution boards, circuit-breakers, wiring (including cables, bus-bars, junction boxes, switches, socket-outlets)

in the fixed installation, and equipment for industrial use and some other equipment, for example, stationary motors with permanent connection to the fixed installation.

Measurement category IV is for measurements performed at the power source of the low-voltage installation. Examples are electricity meters and measurements on primary overcurrent protection devices and ripple control units.

Transient withstand capability

⚠ Maximum input voltage of the analog input

Category I 300Vrms, 400Vpk.

16.2 Pollution Degree

Pollution Degree	Smart Series oscilloscopes can operate in environments with pollution degree 2 (or pollution degree 1).

Pollution Degree Categories	Pollution degree 1: No pollution or only dry, non-conductive pollution occurs. The pollution has no influence. For example: a clean room or air-conditioned office environment. Pollution degree 2: Normally only dry, non-conductive pollution occurs. Occasionally temporary conductivity caused by condensation may occur. For example: general indoor environment. Pollution degree 3: Conductive pollution, or dry, non-conductive pollution occurs which becomes conductive due to condensation. For example: sheltered outdoor environment. Pollution degree 4: Pollution that generates persistent conductivity through conductive dust, rain, or snow. For example: outdoor locations.

Chapter 17 Troubleshooting

1. If the oscilloscope does not start up at power on, please follow steps below:

- Check the power cord to verify whether it has been connected properly and whether the power supply is normal;
- Check the power on/off buttons to ensure it has been pushed, and if you are using battery, check whether the battery is in good condition;
- Check the Power-off lock on the side of oscilloscope;
- Contact Micsig if the problem persists, and we will provide service to you.

2. If acquired waveforms do not display on the screen when the signal source is connected, please follow the steps below:

- Check whether the probe is connected correctly in the BNC socket;
- Check whether the probe is connected correctly in the signal source;

- Check whether the trigger type is correctly selected;
- Check whether trigger conditions are set correctly
- Check whether signal source is working properly;
- Check whether the channel is turned on;
- Check whether the vertical scale factor is set correctly;
- Check whether the instrument is in single-sequence waiting state for trigger
- Tap Run/Stop to resample signal.

3. If the measured voltage amplitude is 10 times greater or smaller than the actual value:

- Check whether the set attenuation factor of the channel is consistent with the attenuation factor of the actually used probe.

4. There is a waveform display, but cannot be stable:

- Check the trigger source on the trigger type menu to ensure that it is consistent with the actually used signal channel;
- Check the trigger type: edge trigger is adopted for general signal, and video trigger mode for video signal. Only the correct trigger mode is used, the waveform can be displayed stably;
- Check signal source noise. Set the trigger coupling mode to be high-frequency rejection or low-frequency rejection to filter out high frequency or low frequency noise interference

5. A waveform is displayed but inconsistent with the input waveform:

- Check whether the coupling mode setting in the channel menu is correct.

6. If there is no display after pressing 

button:

- Check whether the trigger mode is "Normal", and whether the trigger level is beyond the scope of the waveform. Center the trigger level and set the trigger mode as "Auto".
- Check whether the picture is displayed in full screen, and if so, exit the display.

7. If the display becomes slower after setting average times of sampling:

- If the average times are above 32, it is normal for the general speed to become slow.
- You can reduce the average times.

8. Staircase waveform is displayed:

- This phenomenon is normal because the horizontal time base is too low, and the horizontal time base may be increased to raise the horizontal resolution, and then improve the display;
- The display type may be “line”. The connection between sampling points may lead to the display of staircase waveform. This problem can be solved by setting the display type as “point” display mode.

9. There is persistence of vision in waveform display:

- This phenomenon is normal because the persistence time may be set too long, and the waveform persistence shows persistence of vision;
- The reason may be that sampling mode is set to envelope of sampling, and the sampling mode can be modified to normal waveform for normal display

10. During measurement, the measured value is displayed as -----:

- This phenomenon is normal. When the channel waveform displays beyond the waveform display area, the measured value is displayed as -----. If the channel vertical sensitivity or vertical position is adjusted, the measured value can be displayed correctly;
- This phenomenon is normal. When there is no full-cycle waveform in the waveform display area, the measured value may be displayed as -----. If the time base is adjusted, the measured value will be displayed correctly.
- This phenomenon is normal, and the measured value of the FFT waveform is displayed as -----.

11. CSV files cannot be selected when loading reference:

- CSV files are not the supported format that can be loaded into reference channels.

12. Tap the button during the use of oscilloscope, there is no beep sound:

- Check whether the sound volume setting is correct.

13. Oscilloscope backlight has low brightness:

- Check whether the backlight settings are correct.

14. A waveform being moved changes abruptly:

- Check whether the picture is displayed in full screen.

15. Turn off the channel at Auto state:

- This phenomenon is normal. At Auto state, the channel with an amplitude less than 10mV will be turned off.

16. Function buttons are pressed without response:

- Check whether the picture is displayed in full screen.

Chapter 18 Services and Support

Service Commitments : Micsig guarantees that the products are manufactured and tested according to national standards or enterprise standards, no unqualified products will leave our factory and the first-class customer services are provided for all sold products. The warranty period for our products is three years since date of shipment, and three months for the sold spare parts and the product repair and maintenance. For the details of warranty service, please read the "Scope of Limited Warranty and Services" chapter. Micsig provides lifetime repair and maintenance services for products. In accordance with the relevant provisions of after-sale service of industrial products and the enterprise's own capacities, Micsig commit as follows:

Repair Commitments : Micsig commits to use the original factory parts for products returned by the user for repair (under warranty or not) and the commissioning and testing standards are identical with new products. Micsig the obligation to inform the customer, but without any other obligations for non-product defects or products with decreased performance not for objective reasons.

Service Time Commitments : Micsig will give a reply of the time and cost for repair within 2 working days after receiving the product returned by the user for repair. After the reply is confirmed, the repair period for a general fault is 5 working days and shall not exceed 10 working days for any special fault.

Contact us

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Fax: 0755-88600880-818

Website: www.micsig.com

Email: sales@micsig.com

Postal Code: 518126

Annex

Annex A:Maintenance and Care of Oscilloscope

General maintenance

Do not put or leave the instrument in a place where the LCD display will be exposed to direct sunlight for long period.

⚠**Caution:** To avoid damage to the oscilloscope or probes, do not expose them to sprays, liquids, or solvents.

Clean oscilloscope

Examine the oscilloscope and probes as often as operating conditions require. To clean the exterior surface, perform the following steps:

- Use a soft cloth to remove floating dust on the outside of the oscilloscope and probes. Take care to avoid scratching the touch screen while cleaning.

- Use a soft cloth dampened with water to clean the oscilloscope while doing this please keep the power off. Wipe with a mild detergent and water. Do not use any corrosive chemical cleaning agent, in order to avoid damaging the oscilloscope or probe.
- Clean the ventilation hole with a soft brush to keep it unimpeded. Do not use any corrosive chemical cleaning agent, so as to avoid damage to the oscilloscope motherboard.
- If the fan needs to be cleaned, please consult the after-sales service personnel, so as to avoid damage to the oscilloscope.

⚠ Warning

Make sure the instrument is dry before recharging, to avoid electrical short circuit or personal injury caused by moisture.

Store oscilloscope

The lithium battery needs to be charged before storing the oscilloscope for a long period.

Battery charge

Upon delivery, the lithium battery may not be charged. It takes 6 hours to be fully charged (the oscilloscope is recommended to turn off to save the charging time). When running on battery power, the battery level indicator in the lower right corner of the screen will indicate the battery usage.

⚠**Caution:** In order to avoid charging battery from overheating, do not use beyond the permitted environmental temperature value given in the technical specification.

Annex B: Accessories

Standard accessories

1) 4 pcs or 2 pcs for 10X standard probes (incl. grounding nut, grounding crocodile clip, standard rubber plug)
2) Power adapter (12V DC, 4A)
3) Power cord
4) Smart calibration certificate
5) Smart packing list

Optional accessories

1) Oscilloscope suitcase/handbag

2) Battery

3) High voltage probe

4) Differential probe

5) Current probe